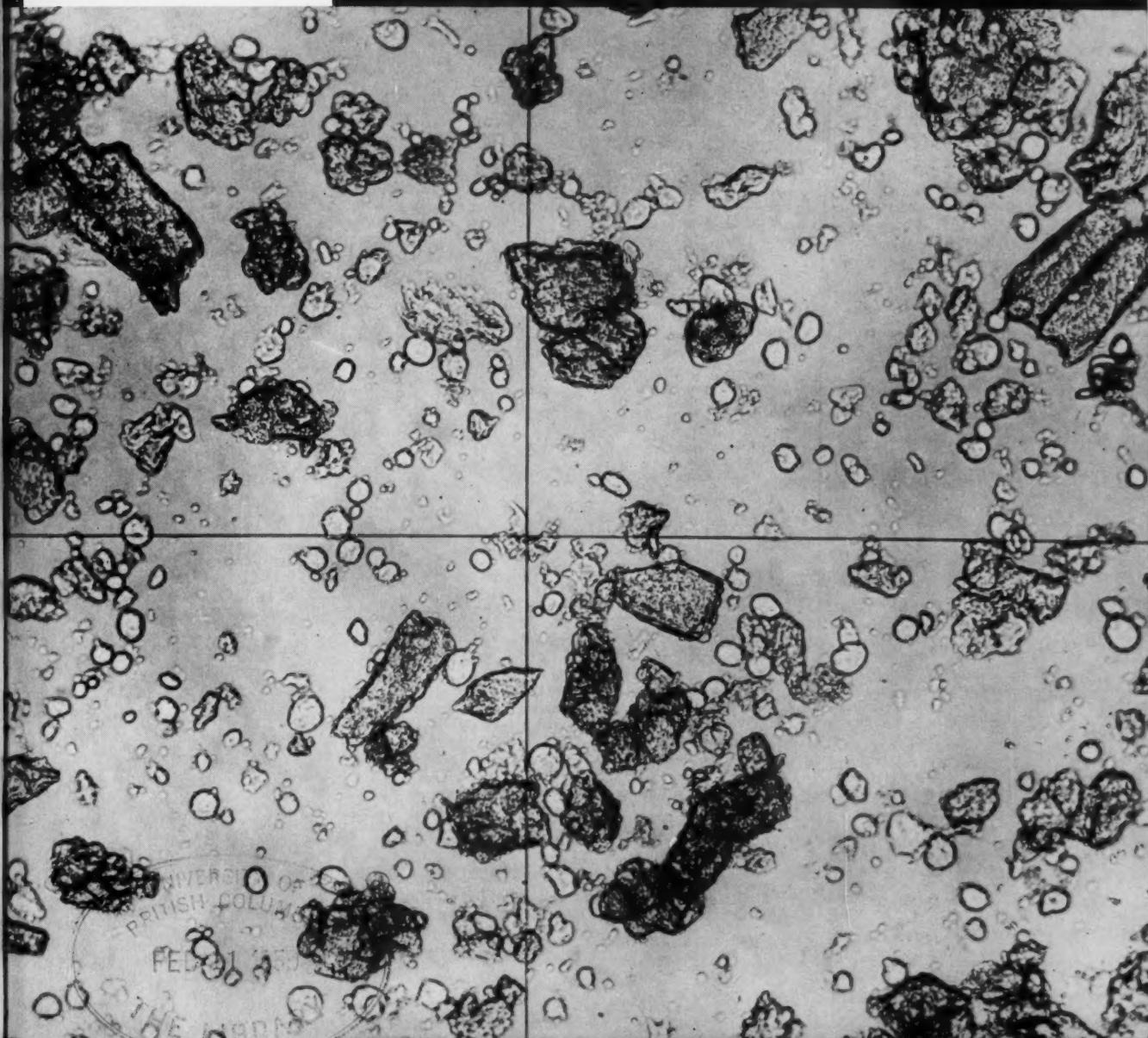


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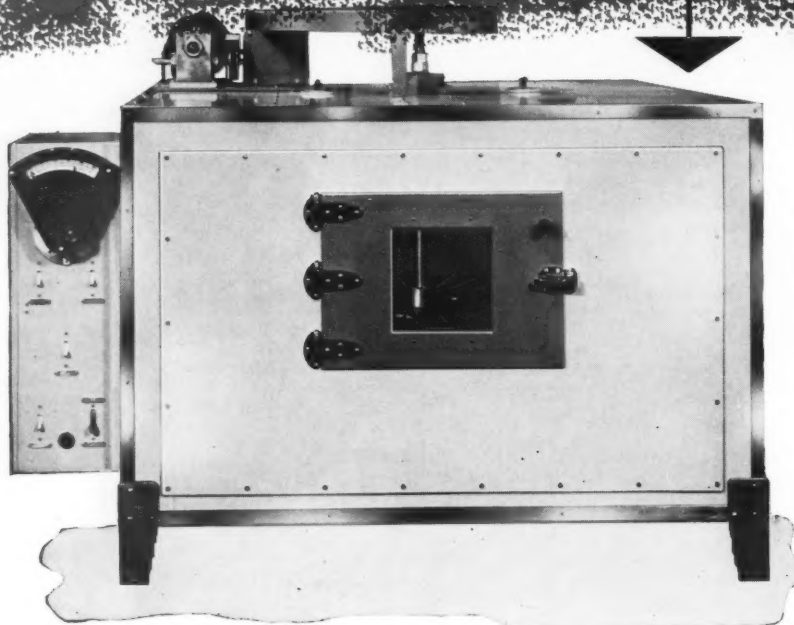
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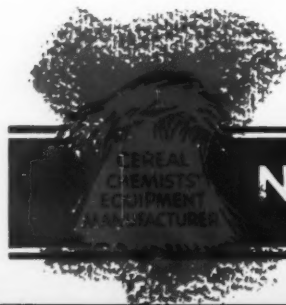
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LINCOLN, NEBRASKA

White Flour in the U.S.A.— Enriched* with Vitamins and Iron for Better Nutrition

by Science Writer

This article is one of a series devoted to the enrichment of family white flour, white bread and rolls, corn meal and grits, macaroni products and white rice.



The enrichment of family white flour with thiamine, riboflavin, niacin and iron by American millers is a major success. It has made great contributions to better health in the United States by improving a staple food.

Since the start of the program in 1941 by millers, voluntarily, the evidence is conclusive that enrichment not only has reduced the number of cases of certain dietary diseases but also is promoting the mental and physical vigor and well-being of the U. S. population generally. Because of its demonstrated value, the principle and practice of enrichment have been applied to other foods made from grains: corn meal and grits, white rice, macaroni, spaghetti, noodles, pastina, farina—and, of course, to white bread and rolls.

Doctors and diet experts have long supported white flour enrichment. The Council on Foods and Nutrition of the American Medical Association and the Food and Nutrition Board of the National Research Council are on record as endorsing the practice.

The legislatures of a majority of the States plus Hawaii and Puerto Rico have enacted laws which make mandatory the enrichment of all family white flour, as well as white bread, sold commercially in those areas.

American homemakers, too, favor foods they know to be enriched—a fact demonstrated by surveys. They look for these words on package labels: "Enriched with vitamins and iron for better nutrition."

What Is Enrichment?

It's an axiom in the milling industry that consumers want beautifully fine, white flour. When wheat is milled and processed to get the white flour which the public demands, vitamin and mineral values are unavoidably lost.

Enrichment restores to white flour the following important vitamin and mineral factors: thiamine, riboflavin, niacin and iron. Calcium also may be added as an optional ingredient. The process is simple and inexpensive. A mixture of the vitamins and iron is fed into the flour stream during processing. This insures that the enriching ingredients are spread evenly throughout the flour.

The U. S. Food and Drug Administration has established standards which white flour must meet to be prop-

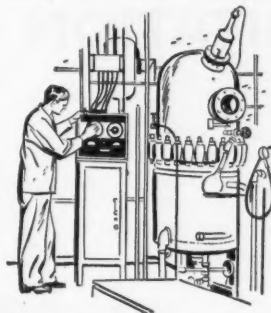
erly labeled enriched. The requirements, in milligrams per pound, are:

	Min.	Max.
Thiamine (vitamin B ₁)	2.0	2.5
Riboflavin (vitamin B ₂)	1.2	1.5
Niacin (another "B" vitamin)	16.0	20.0
Iron	13.0	16.5

(In Canada, too, the same standards have been set for enriched white flour through the amendment of the Food and Drugs Act.)

Vitamins Are Made

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Reprints of this article, and all others in this series are available without charge. Please send your request to the Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada:

Hoffmann-La Roche Ltd., 286 St. Paul Street, West; Montreal, Quebec.



The watermills are gone. Today's needs require today's methods. How sensible it is that millers across the nation restore health-giving vitamins and minerals through enrichment.

*Webster's Merriam Collegiate Dictionary includes this definition of "enrich": "to improve (a food) in nutritive value by addition in processing of vitamins and minerals".



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Today

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COVER: Photomicrograph of hard wheat flour in transmitted light.
 Photo courtesy of Victor Chemical Works, Chicago Heights, Ill.

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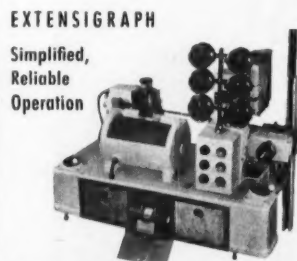
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Editorial

JUST BEFORE THIS issue went to press we received the first material for a new department that will appear in CEREAL SCIENCE TODAY, beginning next month. We hope your reception of it is as enthusiastic as our feeling about its possibilities.

The idea for this new feature sprang from the observation that just about all the cereal chemists we know take pride in demonstrating some degree of inventive ability. They are also quick to recognize the merit in someone else's idea, adopt it, and improve upon it. This is why we think that people working in cereal laboratories everywhere will welcome an opportunity to exchange novel ideas and descriptions of gadgets that they have found make their jobs easier. We intend to provide space in CEREAL SCIENCE TODAY for just that purpose.

Those who put to use some of the ideas that are published will want to replenish the supply by sending in their own innovations. Those who don't find anything worth adopting should feel an even greater motivation to contribute the sort of thing they think should be published. The forum is open to all; it is not limited to AACC members.

Editor of the new *Laboratory Helps and Gadgets Department* will be Ross Cory. We earnestly solicit your cooperation in sending your ideas to Mr. Cory's attention. Contributions can be brief. One drawing or photograph may be clearer than a thousand words of description. One good idea can lead to several more. What is yours?

P. E. RAMSTAD



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A WINDOW ON
METHODS AND PROBLEMS
IN TODAY'S

Macaroni Industry

By Charles M. Hoskins, Glenn G. Hoskins Co., Industrial Consultants, Libertyville, Illinois

MACARONI IS THE generic term for the class of products made by forming unleavened dough into a variety of shapes and drying to 13% moisture or less. The FDA Standards of Identity for macaroni products limit the permitted ingredients rather severely. Basic raw material can be semolina, durum flour, farina, flour, or any combination of two or more of these, with water. Optional ingredients are egg-white solids from 0.5 to 2.0% of the weight of the finished food, disodium phosphate, onion, celery, garlic, bay leaf, salt, or other seasoning. Gum gluten can be added in such quantity that the protein content of the finished food is not more than 13% by weight.

Milk macaroni is permitted by the Standards, but rarely made. The same is true of whole-wheat, soy, and vegetable macaroni products containing such things as tomatoes and spinach.

When eggs are added to macaroni products, they become egg macaroni or noodles. Noodles are formed in ribbon shape and by definition contain not less than 5.5% by weight of the solids of egg or egg yolk as a percentage of the total solids.

Enrichment of macaroni and noodles is a widespread practice, obtained by adding to each pound:

	Not less than mg	Not more than mg
Thiamine	4.0	5.0
Riboflavin	1.7	2.2
Niacin or niacinamide	27.0	34.0
Iron	13.0	16.5

Enrichment can be put in by means of synthetic mixtures, or yeast. To compensate for loss in the cooking water, required amounts of thiamine, riboflavin, and niacin are higher than those for bread flour.

Basic Manufacturing Processes

Most macaroni products are made by extruding a stiff dough through holes in a thick plate called a die. Semolina or flour is mixed with water to give a dough containing approximately 31% moisture (wet basis). This dough is kneaded to form a homogeneous mass and then extruded, under pressure ranging from 1,500 to 3,000 lb. per sq. in., through holes in a metal die.

In a preliminary dryer, the moisture content of the formed product is reduced in about 30 minutes from 31 to 24% ($\pm 3\%$). This case-hardens it, and a resting period of 1 to 2 hours permits interior moisture to diffuse to the surface, so that the product becomes relatively flexible and uniform in moisture content. The moisture is then reduced to 13% or less over a long period of time in air of high humidity. This finish-drying time varies from about 5 hours for noodles to as much as 3 days for large-diameter long macaroni.

A number of products are formed from a thin sheet of dough which has been extruded from a slotted die or rolled and laminated several times. Noodles are the most important of these. To make them, the sheet is rolled to approximately 0.033 in. thick and cut to the desired width and length. Other more complicated products are stamped out of the sheet. The most commonly used stamped products in the United States are "bow ties": rectangles are punched out of the sheet and pinched together at the middle in miniature bow-tie shape.

Drying Macaroni

If macaroni products are dried too slowly, the high moisture content permits the growth of molds and other spoilage organisms. If drying is too

rapid, stresses will cause the finished product to crack or "check." Drying times have been continually reduced over the past few years, so that mold growth is not usually a serious problem, although it occurs occasionally for one reason or another. But the tendency of macaroni products to check has been one of the curses of the industry, and a great deal of time and thought has been given to methods of preventing this fault.

Causes of Checking

Earle¹ has shown that stresses set up by differences in moisture content within the macaroni are responsible for checking. Stresses caused by temperature differences, however, have very little effect on the product. This is shown by the fact that the coefficient of thermal expansion averages 58×10^{-6} per degree F., whereas the coefficient of moisture expansion averages 4×10^{-3} per percent moisture on a dry basis. Calculations showed that the thermal stress set up by moving macaroni from 90° to 70°F. air was 18.7 lb. per sq. in., whereas the stress set up by moving macaroni from 65 to 80% relative humidity was 4,700 lb. per sq. in.

There are several processes which may be responsible for checking, and each causes a characteristic form. Compression check, the most simple type, occurs when dry spaghetti is subjected to a very humid atmosphere. Water condensing on the surface expands it and causes it to pull away from the interior, until the spaghetti checks. In a nonvacuum spaghetti (to be described later on) this check will consist of a crack just under the surface at about a 30° angle

¹ Earle, P. L. Studies in the drying of macaroni. Factors in checking. Univ. of Minn., thesis (1948).

to the axis, extending down into the interior and returning to the surface to form a boat-shaped check. With the more homogeneous vacuum product this defect shows up as breaks in the interior of the spaghetti, perpendicular to the axis. This is a very troublesome kind of check, since it causes the product to fall apart upon cooking.

Tension check occurs when a fairly dry spaghetti is exposed to a very dry atmosphere and moisture is removed from the surface; rapid contraction and cracking ensue. Characteristically, this kind of check appears as a network of extremely fine lines on the surface, so small that they may appear merely as a lightening of the color. This check does not cause disintegration in cooking and so is relatively unimportant.

If a large moisture gradient is maintained by rapid drying while the dough is plastic, and is continued as moisture is removed and the macaroni becomes brittle, there will be a difference in density of solids in the interior and on the surface when drying is stopped; the moisture in the interior will migrate toward the dry exterior and cause it to expand. Sometimes checking will occur within a few hours, but it has been known to take as long as 24 weeks. This is the most common type of check; a very serious problem, because a product, packaged in an apparently sound state, may check in the package before it reaches the consumer.

If preliminary drying is carried too far so that first the product is case-hardened and then moisture is further removed from the interior, the interior will shrink more than the surface, causing ruptures. These appear as a string of beads or bubbles in the translucent interior of spaghetti. They do not cause disintegration upon cooking, but they are serious because they affect appearance; to an inexperienced eye, the product looks as though it is checked.

Drying rates can be kept low enough so that checking does not occur, by control of the temperature and humidity of the circulating air in the dryer. For each temperature and humidity of the air there is a corresponding equilibrium moisture for macaroni or noodles. This equilibrium moisture is not the same for all raw materials and may be affected by previous treatment in the press and

the previous drying history of the particular sample tested. For this reason, equilibrium moisture data are scattered considerably. A representative equilibrium moisture curve, determined by Earle (1), is shown in Table I.

Table I. Equilibrium Moisture of Macaroni and Egg Noodles at 90°F.

Relative Humidity	Equilibrium Moisture	
	Macaroni	Egg Noodles
%	% dry basis	% dry basis
90	22.0	
80	18.2	
70	16.0	14.0
60	13.9	11.9
50	12.1	10.0
40	10.5	8.5
30	8.8	...
20	7.0	...
10	4.9	...

Drying Rates. On the basis of extensive drying tests run by the author on spaghetti with a diameter of 0.069 in., with an air velocity between 150 and 300 ft. per minute, and with temperatures varying from 90° to 170°F., drying rates can be calculated by means of the following formula:

$$\log \frac{F_0}{F} = KAt \quad (1);$$

where

F = percent free moisture = $M - M_e$;

M = percent moisture in macaroni (dry basis);

M_e = percent equilibrium moisture (dry basis);

K = a constant experimentally determined to be 0.0406;

A = sq. ft. of surface area of macaroni per lb. of bone-dry solids;

t = time in hours;

F_0 = free moisture at zero time; and log = logarithm to the base 10.

$$A = \frac{0.61D}{D^2 - d^2} \quad (2),$$

where

A = sq. ft. of surface area per lb. of dry solids;

D = outside diam. (in.); and

d = inside diam. (in.).

Then:

d = 0 for spaghetti and the equation reduces to:

$$A = \frac{0.61}{D} \quad (2a).$$

Substituting in equation 1:

$$\log \frac{F_0}{F} = \frac{0.0248Dt}{D^2 - d^2} \quad (3).$$

From equation 3, we can derive equation 4:

$$t_a = 12.1 \frac{D^2 - d^2}{D} \quad (4),$$

where

t_a = the time in hours required to reduce the free moisture to half its initial value;

D = outside diam. of macaroni (in.); and

d = inside diam. of macaroni (in.).

Example: Plot a drying curve for spaghetti of 0.072-in. diameter with an initial moisture content of 31% (dry basis), dried in an atmosphere of 90°F. and 80% r. h.

Solution: From Table I, we find that the equilibrium moisture is 18.2% (dry basis) at 80% r. h.

$$t_a = 12.1 \times 0.072 = 0.87 \text{ hours}$$

$$F_0 = 31 - 18.2 = 12.8$$

For every 0.87 hours, the free moisture is halved. A calculated drying curve is shown in Table II.

Table II. Calculated Drying Curve for Spaghetti

Time	Free Moisture ^a	Total Moisture ^a
hours	%	%
0.0	12.8	31.0
0.87	6.4	24.6
1.74	3.2	21.4
2.61	1.6	19.8
3.48	0.8	19.0
4.35	0.4	18.6
5.22	0.2	18.4

^a Percent bone-dry basis.

Macaroni Presses

Today, practically all macaroni products in this country are made on continuous presses, varying in capacity from approximately 200 to 1,500 lb. of dried product per hour.

Normally, water is proportioned into the mixer by means of a constant head device feeding a manually operated proportioning valve. Semolina and flour are proportioned by means of volumetric or gravimetric feeders. The most common type of flour feeder is a simple volumetric device consisting of a short belt conveyor about 6 in. wide by 12 in. long, passing under the feed inlet. An adjustable gate, combined with the constant speed of the conveyor belt, controls the volume of the flour or semolina being fed into the mixer.

The Merchen feeder has been used in the U. S. for gravimetric feeding

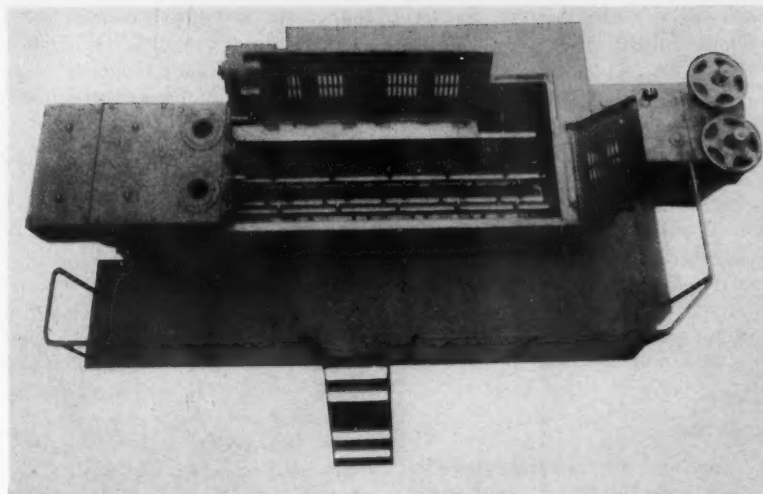
of flour. It consists of a conveyor belt, a portion of which is supported on a scale platform. The depth of feed on the belt is controlled by a gate, which in turn is controlled by the weight on the scale platform. In Europe, several intermittent scales have been used. These usually weigh 1 kg. per cycle. The water or egg solution is measured volumetrically and flows into the mixer at the same time that 1 kg. of flour is dumped in.

The flour and water are combined at one end of a long mixer having one or two high-speed mixing shafts with blades which are set to convey the dough slowly from the feed end to the opposite end of the mixer. Some presses are equipped with a single long mixer; others have the long mixer and a short additional one which feeds into the extrusion auger. The dough mix is much dryer than bread dough and should normally be kept at a moisture content which will give dough balls between $\frac{1}{2}$ and 1 in. in diameter. These balls will feed into the extrusion screw which operates in a corrugated steel cylinder to convey the dough to the extrusion head and build up the 1,500 lb. of pressure required to extrude the dough through the macaroni die. A considerable amount of kneading takes place in the extrusion screw. Some of the heat thus generated is removed by a cooling jacket around the cylinder. In most American presses the dough is heated up by working to a temperature of 100°F. or more.

Short-cut Products

Short-cut macaroni products are extruded through a round die about 2 in. thick and 14 in. in diameter, containing 1,000 or more holes. Such dies are usually made of cartridge brass, although stainless steel has been used because of its superior ability to withstand wear. It is generally thought that bronze dies give a smoother product and a deeper yellow color. Whether this is due to the superior heat conductivity of the bronze or to the difference in friction characteristics is not known.

The most common short-cut product is elbow macaroni of various lengths and diameters. For this the extrusion hole is wider at the top of the die than at the bottom, and a pin with fins, shaped very much like a bomb, is fitted tightly in this hole so



Top view of a macaroni press showing large and small mixers. Semolina and water are fed in at left end of mixer. Extrusion screw picks up dough at bottom of small mixer. (Courtesy of Buhler Bros., Uzwil, Switzerland.)

that the tip of the pin is centered in the extrusion hole at the face of the die. Dough flows around the fins and is rejoined under high pressure before extrusion through the outlet hole. To put the curl in elbow macaroni, the large portion of the hole is drilled slightly deeper on one side of the pin than on the other; thus there is less resistance to flow, and the dough flows faster on the deeper side. The elbows are cut to length by a rotating knife held by springs against the surface of the die.

Pastina, alphabets, and other small soup shapes are extruded in the same way as elbows, but are cut much shorter; to do this, the knife is rotated faster and several knives are used on the rotating knife support. Straight short-cut products such as mostaccioli are allowed to hang 18 in. or so below the face of the die. The strands pass through holes in a conical cutting device and are cut off at an angle by knives on the lower surface of the cone. Manicotti, a product approximately 6 in. long and 1 in. in diameter, is made in this fashion.

Long Products

Long macaroni products are extruded through a rectangular die approximately 48 in. long by 4 in. wide; the product hangs below the die in two or three sheets. Sticks moving from the back of the spreader to the front pick up these sheets so that they hang down on either side of the stick. The strands are then cut off at the face of the die by a knife, and the

uneven lengths (resulting from varying rates of extrusion) are trimmed by an oscillating knife much like the sickle on a mowing machine.

The problem of getting the dough from the extrusion worm to the long die is a rather difficult one. Networks of tubes in various patterns have been used. In one spreader there is a single tube from the screw to the center of the die, and then an auxiliary screw with right- and left-hand pitch forces the dough out to the ends of the die. In another press, two screws discharge directly into the die head, so that the dough does not have to flow as great a distance as from a single screw discharging into the center of the die head.

The problem of distribution is difficult because the dough becomes softer as it is maintained under pressure and heat, and this softness is increased by friction caused by flow. Soft dough extrudes more rapidly than hard dough, so that a great amount must be trimmed off the macaroni to make the lengths uniform. This has been a particularly serious problem in 1958 because of sprouted durum wheat caused by extensive rains at harvest time. As much as 35% of the product from the die has been trimmed and returned to the mixer.

Noodles can be extruded directly from a die as in the case of short cuts, but it is more common to extrude a sheet of dough approximately 22 in. wide and from 0.06 to 0.125 in. thick. This sheet is reduced to the desired

thickness by rollers and then cut on a noodle cutter.

Most packaged noodles today are scattered at random, forming a fluffy, tangled mass which is fairly bulky and looks attractive in cellophane bags. Occasionally noodles are folded into a regular pattern 2 to 3 in. wide and the total width of the original dough sheet. Thin spaghetti or vermicelli is sometimes folded in a figure-eight pattern to form a single biscuit approximately 4 by 2 in. Noodles and vermicelli can also be twisted into a round "bird's nest."

Teflon Dies

Teflon dies have been extensively used to make the noodle sheet more smooth so that the yellow color will be deeper. The Teflon die has made it possible to produce 1,500 lb. per hour on a press extruding a sheet 22 in. wide. The dough is worked less in passing through the Teflon slot because of the very low coefficient of friction of the Teflon, so that a sheet 0.125 in. thick can be made. Also, the extrusion rate can be much greater in linear inches per minute with Teflon, because the dough is heated less in passing through the hole than with a bronze die. When a 0.125-in. sheet extruded from a bronze die is reduced by rolls to the 0.033 in. normally used for noodles, white strain marks, looking very much like the grain of oak wood, appear in the noodles. This does not occur with the Teflon die.

Teflon has also been used for making regular extruded spaghetti and macaroni products. This practice is widespread in Europe and is used

more with egg products than with plain macaroni products. The Teflon product takes slightly longer to cook than the standard product and there is a slight tendency for the surface to become slimy upon overcooking.

Vacuum Mixing

In 1937, Fifield, Smith, and Hayes (2) developed a method for preparing microdisks of macaroni dough for studying color characteristics of durum wheat varieties. These disks were made by pressing a dough of the flour to be tested in a hydraulic press at various pressures and for various times. It was found that unpressed disks contained many air bubbles, averaging 20 microns in diameter. When pressure was applied for 4 minutes at 3,000 lb. per sq. in., the diameter of the bubbles increased to 800 microns and the number of bubbles decreased in the ratio of 1 to 40,000. At the same time, light transmission through the disks increased sixfold. This indicates that the depth of yellow color in manufactured macaroni products depends on the number of air bubbles present, and this, in turn, is a function of the amount of pressure applied and the time for which it is applied.

The vacuum process carried this reasoning to the logical extreme. A vacuum was applied to the mixer or extrusion screw to remove the air, and hence there were no air bubbles in the macaroni. This resulted in a translucent product with a deep yellow color, which proved to be more attractive in appearance than the non-vacuum product. Teflon dies further increased the smoothness and translucency, and resulted in an even more homogeneous and deep-yellow color.

Drying Processes

Historically, short goods were dried on trays in a stationary dryer with air circulating through or across the product. This method is used in isolated cases, especially with very large, hard-to-dry products. Most short-cut macaroni today, however, is dried on wire-mesh screens in continuous dryers, having usually three or four separate units with separate temperature and humidity conditions within each unit. A typical dryer would have a preliminary dryer 24 ft. long with four screens 5 ft. wide, carrying the product back and forth from one end of the dryer to the other. A dis-

tributing device spreads the product approximately one layer deep on the top screen. Temperature and humidity are accurately controlled. Leaving the preliminary dryer at approximately 23% moisture, the product is conveyed to the first of two finishing dryers, each about 41 ft. long with a resting belt and four drying screens. Total drying time is about 12 hours. Air circulation might be countercurrent, concurrent, or across the width of the screen, depending on the particular manufacturer.

Drum dryers made by The Braibanti Company of Milan, Italy, are widely used in Europe. These drums are made with a number of very small compartments separated by wooden partitions in such a way that the product will advance horizontally a few inches each time the drum is rotated. The entire drum is covered with wire mesh and air is circulated through it. This system causes the goods to be turned over continually and held in relatively small portions so that air reaches every piece of macaroni.

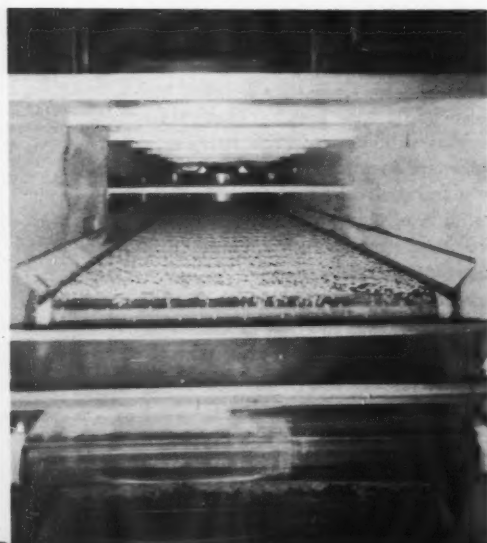
Long Goods Drying

Long goods are commonly dried in the United States on a continuous preliminary dryer and batch-finishing dryers.

The preliminary dryer consists of a cabinet containing conveying chains which pick up the sticks of spaghetti and take them through three horizontal passes, each approximately 24 ft. long. Drying is generally accomplished on the top pass only; the bottom two passes go through resting chambers which allow the moisture to equalize itself from the interior to the case-hardened surface. The long macaroni product is supported on sticks 54 in. long and $\frac{7}{8}$ in. in diameter, and is usually cut approximately 21 in. long on each side of the stick. Drying time is from 30 to 40 minutes and resting time usually about 2 hours, so that the total time in the preliminary dryer is about 2.5 hours. Moisture content is reduced to about 24%.

A preliminary dryer developed by DiFrancisci Macaroni Machine Company of Brooklyn, New York, dries with air passing down through the goods on the top pass and up from the bottom to the top of the strand in the second pass, only the last pass being used for resting. This dryer

Macaroni product spread evenly on top screen of preliminary dryer.



removes 2 or 3% more moisture than the single-pass dryer and thus reduces the time needed in the finishing dryers.

From the preliminary dryer the sticks are placed on racks mounted on casters; usually three tiers support approximately 20 sticks each, so that a truck 42 in. wide by 78 in. high by 56 in. long will hold about 60 sticks or 300 pounds of macaroni. From 12 to 24 of these trucks are placed in a drying room. In the past there have been many arrangements of fans; the most common now is a number of fans overhead in one or two bulkheads, reversing at 1- or 2-hour intervals. This allows the front of the room to dry for a short time and then to rest as the fans are reversed and the back end of the room dries. Humidity is lower, so that the total amount of moisture removed per hour is increased without causing checking. The total drying time is a function of the amount of air circulated per minute per pound of goods in the room. With more air, the drying time is shorter, since there is less tendency for part of the room to lag behind fast-drying parts. Drying time for spaghetti varies from 18 to 36 hours in modern stationary dryers.

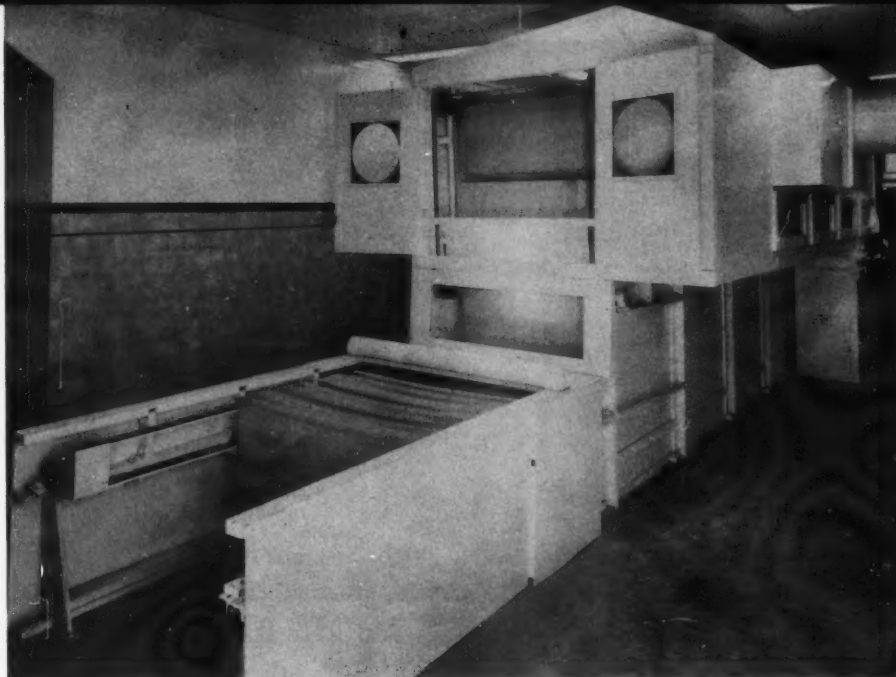
Continuous dryers for long goods are in use in both the United States and Europe.

Noodle Drying

Noodles are dried in much the same manner as short cuts. They are not piled as deeply on the first screens of the dryer, so that they will dry more evenly, but are piled up deeper on the last screens. This system is necessary because noodles have a tendency to stick together and form lumps, and because they are much bulkier than short cuts whose density may be about 20 lb. per cu. ft. whereas that of many noodle products is 7 lb. per cu. ft.

In drying noodles, great attention must be paid to the conveying means. Noodles will stick together if they are piled up on the way from the press to the preliminary dryer. Furthermore, if cold noodles are introduced into a hot, humid dryer, moisture will condense on the surface and cause sticking.

Folded and twisted goods are usually dried on trays because they must remain in their original configuration until drying is complete. These



Preliminary dryer for long spaghetti.

trays are put on trucks and wheeled into batch-drying rooms very similar to long-goods rooms.

Braibanti has developed a continuous tray dryer which pushes the trays back and forth through a drying chamber 52 times on 52 levels. The trays are automatically unloaded by means of rotating brushes, and returned to the press.

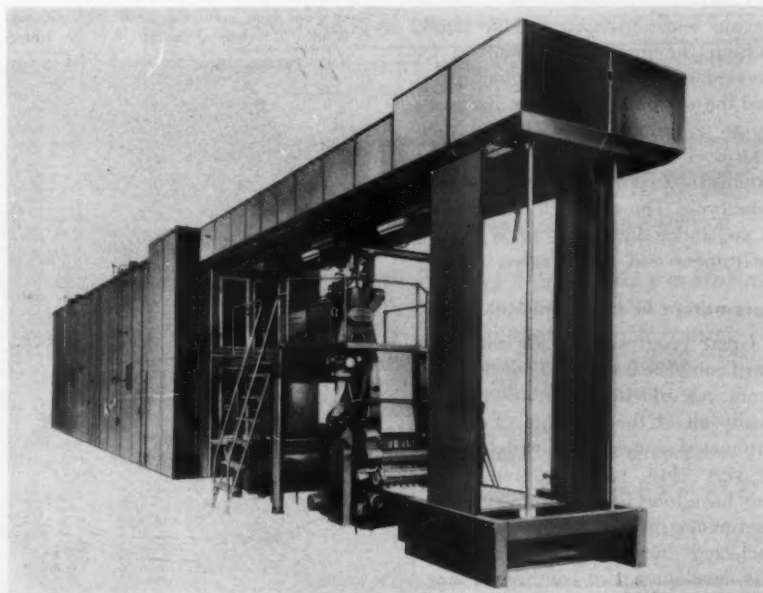
Temperature Controls:

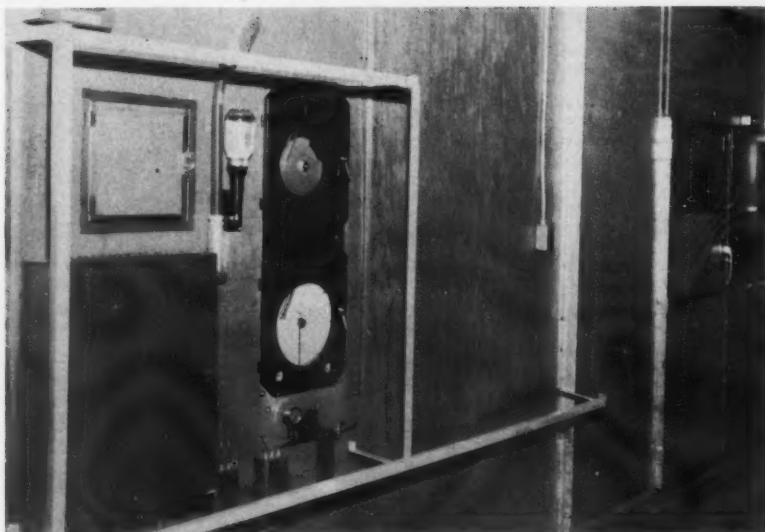
Wet and Dry Bulb

The drying rate of macaroni depends on the moisture content of the macaroni itself and the temperature

and humidity of the drying air. Because of macaroni's extreme sensitivity to drying rates, a great deal of work has been done on the application of controls to dryers. For temperature control there are wet bulb and dry bulb control instruments. Some success has also been attained by controlling the difference between the wet and dry bulb temperature directly; the dry bulb temperature is allowed to seek its own level, and fresh air and heat are applied when the differential drops too low.

Continuous production line for making and drying noodle nests. Trays pass through dryer and are automatically emptied and then returned to press. (Courtesy of Braibanti, Milan, Italy.)





Long-goods dryer equipped with time schedule controller which automatically adjusts wet and dry bulb temperatures according to cams shown in upper part of instrument.

In batch dryers, wet and dry bulb temperatures must be changed according to a predetermined schedule. Usually the wet bulb depression (the difference between wet and dry bulb temperatures) must be small at the beginning of the drying cycle and must gradually increase until the product is dry. These drying schedules can be automatically maintained by time schedule controllers, which adjust the set points of the wet and dry bulb control system according to a schedule cut on a pair of cams.

In another system, the amount of exhaust and intake air and the conditions of the area surrounding the dryers are all accurately controlled. From the maximum during initial stages of drying when moisture in the goods is high, the amount of exhaust is decreased as the moisture content drops and the wet bulb depression increases up to a certain value. Timers then take over and adjust the amount of exhaust according to a predetermined time cycle. The dry bulb temperature is controlled by means of a control instrument and steam valve.

Automation in Macaroni-Making

Great progress is being made toward complete automation of the macaroni manufacturing process. Practically all of the elements of a fully automated system are available now or very close to completion. Short cuts have long been manufactured on continuous presses and dryers and packaged by automatic machinery. The development of continuous long-

goods dryers, automatic machines for removing the macaroni from the drying stick and cutting it to length, and automatic long-goods weighers promises that a completely continuous and automatic long-goods line will be available in the near future.

Progress in Drying

Drying is a weighty problem because of the long time required, the large amount of space occupied by drying equipment, the large investment in drying equipment, and the danger of a product ruined by checking or mold formation. If drying time could be reduced and the reliability

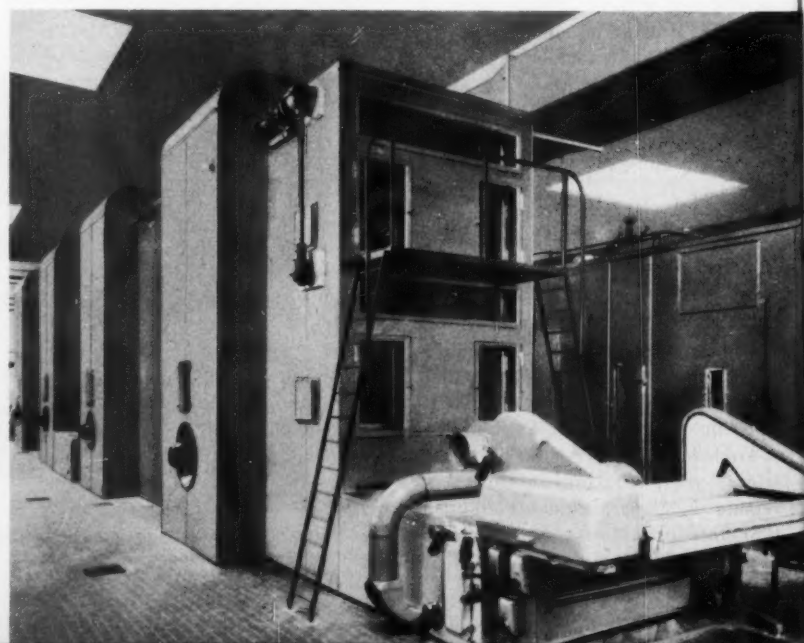
of the process increased, a considerable saving in space and possibly in equipment cost could be realized.

It has been found that macaroni products can be dried more rapidly without checking if drying temperatures are raised. Spaghetti with a diameter of 0.069 in. can be dried in 7.5 hours from press to package at 150°F., and research at even higher temperatures in Europe and the United States encourages us to believe that possibly even shorter drying times may be realized. Several causes may be responsible for the lower drying time at high temperature: the increase in strength of the product owing to the denaturation of protein and gelatinization of starch; the fact that dough flows more easily to remove stresses; and the possibility that moisture may diffuse more rapidly within the strand of macaroni product.

With controls for temperature and humidity becoming more common, the reliability of the machinery is enhanced. Work is being done also on improving air circulation to make drying in batch dryers more uniform and thereby reduce total drying time as well as improve reliability of the dryer.

With continuous dryers for long goods, less space and less drying time are required. Each strand of macaroni is subjected to the same conditions of air circulation and atmosphere, since the product moves through various humidity and tem-

Continuous long macaroni dryer with automatic device for removing sticks and cutting macaroni to length. (Courtesy of Braibanti, Milan, Italy.)



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perature zones in the dryer. This solves the outstanding problem of batch dryers: that some parts of the room are reached by the air only after it has passed through a considerable amount of wet macaroni in other parts of the room.

Control of Quality

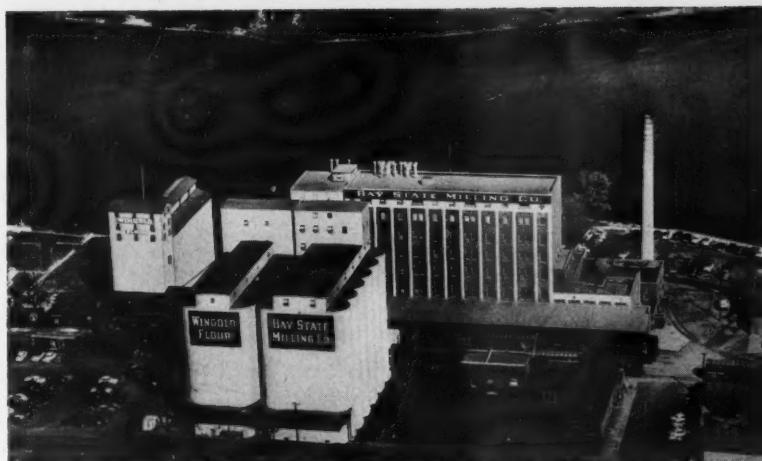
The color of macaroni has received much attention over the past 30 or 40 years from the double standpoint of raw materials and processes, and a satisfactory yellow color of both plain and egg products has been achieved. However, more work is needed in determining the effect of raw materials on the processing and cooking characteristics. In cooking, macaroni is dropped into boiling water; it absorbs water, swells, and becomes softer; and heat gelatinizes the starch and denatures the protein. The Italians consider that cooking is complete when the solid core of uncooked dough disappears. When cooked beyond this point, it becomes still softer and gradually disintegrates. One of the most important quality characteristics of a good macaroni product is its resistance to overcooking. This can be measured by determining 1) the weight increase and 2) the amount of solids which have been dissolved or suspended in the water after 10, 20, and 30 minutes of cooking.

Work is going forward rapidly, with much still to be done, however, in correlating the characteristics of durum wheat varieties, processing methods, and growing conditions with the cooking qualities of the finished product.

In macaroni products the cereal chemist has a unique opportunity to do basic research on dough properties. Macaroni dough, made from flour and water (or semolina and water), is the very simplest dough possible; and the spaghetti shape, being a simple cylinder, permits accurate measurements of physical qualities such as modulus of elasticity, expansion and contraction due to absorption of water, and the effect of a continuously applied load on the deformation of a spaghetti strand. Studies of these dough characteristics could yield information of great significance.

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OF IMPORTANCE
TO THE
BAKING INDUSTRY

Dry Milk—Processing for Specific Uses

By R. P. Choi, American Dry Milk Institute, Inc., Chicago, Illinois

THE MANUFACTURE of dry milk products represents a major branch of the dairy industry in the United States today. According to statistics compiled by the American Dry Milk Institute for 1957, production of nonfat dry milk, dry whole milk, and dry buttermilk amounted to 1,860 million pounds. Of this total, 1,692 million pounds were nonfat dry milk, 97.3 million pounds were dry whole milk, and 69.2 million pounds were dry buttermilk solids. As a comparison: 20 years ago the total production was only slightly over 300 million pounds and as recently as 1952 only 1,010 million pounds. Nonfat dry milk is by far the most important of the dry milk products from the standpoint of production and utilization.

Uses by the Baking Industry

The largest single domestic market for nonfat dry milk at the present time is the baking industry. Of the 911 million pounds of nonfat dry milk sold domestically in 1957 for various commercial uses, 332 million pounds went into the production of bread and related bakery items, and 53 million pounds into prepared mixes. Other major markets for nonfat dry milk in 1957 included dairy uses, such as cottage cheese, 217 million pounds; consumer packages, 155 million pounds; and meat products, 109 million pounds. Aside from nonfat dry milk, in 1957 the baking industry used 4.1 million pounds of dry whole milk and 27.5 million pounds of dry buttermilk. The demand for the latter product appears to be increasing.

Some of the advantages which make nonfat dry milk and other dry milk products attractive to the baking

industry are their high nutritive value, excellent stability under ordinary conditions of storage, convenience, product uniformity, and economy. In addition to these general advantages, the use of milk solids in bread has been demonstrated to result in improvements in taste and flavor, grain and texture, toasting qualities and keeping quality.

A Variety of Dry Milks

In recent years, with expanding utilization of dry milk products, there has been emphasis not only on improving the product, but on tailormaking products with different properties for different applications. As a result, a variety of dry milk products are commercially available today. They differ in several ways: in composition, depending upon the nature of the fluid milk products from which they are made; in the drying process used for manufacture; and in the degree of heat-treatment given the milk or condensed milk prior to drying.

The three most common types of dry milk products are nonfat dry milk, dry whole milk, and dry buttermilk. Dry whole milk, as the name implies, is derived from fluid whole milk. Nonfat dry milk results from the drying of separated or skimmilk. Dry buttermilk is derived from fluid sweet-cream buttermilk, which is the product remaining from the churning of uncultured cream into butter. Drying is usually done by either the spray process or the atmospheric roller process. Nonfat dry milk is further modified by the so-called "instantizing" process. The method of manufacture has no appreciable effect on the gross composition of the finished product, so that for any given product the composition is essentially the same, re-

gardless of the process used. The following table gives the composition of the three types of dry milk products mentioned above:

Table I. Composition of Dry Milks

	Nonfat Dry Milk	Dry Whole Milk	Dry Butter- milk
	%	%	%
Fat	0.70	26.75	5.00
Protein ^a	36.00	26.00	34.00
Lactose	51.00	38.00	48.00
Mineral	8.20	6.00	7.90
Moisture	3.00	2.25	3.00
Calcium	1.31	0.97	1.30
Phosphorus	1.02	0.75	1.00

^a N X 6.38.

The following sections will review briefly the processing of these products, variations by which their properties and uses can be changed, and, as far as possible, some of the tests which have been employed to determine suitability for specific uses. The discussion will deal mainly with nonfat dry milk, although for the most part the information will apply equally to the other dry milk products.

Processing Operations:

Preheat Treatment

The three major steps involved in converting fluid separated milk into nonfat dry milk are 1) preheating of the fluid milk, 2) condensing, and 3) drying. Each of the three steps can, in various degrees, produce definite effects on the characteristics of the finished product. Of the three, preheating of the fluid separated milk prior to condensing has been utilized to the greatest extent to obtain certain desired properties.

Preheating, of course, includes pasteurization, which involves the heating of milk at not less than 145° F. for a continuous period of not less

than 30 minutes, or at 161°F. for not less than 15 seconds, or for any temperature-time combination which will give equivalent results in bacterial destruction. All milk to be processed into dry milk products must be pasteurized.

Depending upon the end use intended for the dry milk, the temperature of the preheat treatment may vary from those required for pasteurization, mentioned above, to above the boiling point of milk. In making cottage cheese it is necessary to avoid as much denaturation of the milk proteins as possible, to obtain good curd-forming properties. For this reason the preheat-treatment is generally not much above that required for pasteurization and, ideally, should not exceed that for pasteurization. This type of nonfat dry milk is usually referred to as low-heat or cottage cheese-type nonfat dry milk and is made by the spray-drying process.

For bread-baking, on the other hand, milk must be preheated to a rather high temperature for a prolonged period. It is well recognized that improperly heat-treated milk or nonfat dry milk prepared from it may cause slackness of dough, small loaf volume, and harsh open grain and texture when used in yeast-raised products such as bread. Although work at the University of Minnesota (5) has indicated that optimum loaf volume is obtained with milk heat-treated at 165°F. for 30 minutes, the dry milk industry generally uses a minimum heat-treatment of 185°F. for 20 minutes. In some continuous operations a preheating temperature as high as 250°F. for a matter of seconds has also been employed. Nonfat dry milk manufactured by this process is generally given the term high-heat or bakery type.

While the method of manufacturing bakery-quality dry milk through the use of high-heat treatment is well recognized, the mechanism by which improvement in baking quality is obtained by heat-treatment of the fluid milk is not as yet completely understood. Effort has been made to determine and isolate the factor or factors responsible for poor bread-baking quality. Latest research findings (3) indicate that there is a component in the whey protein fraction or, more specifically, the lactoglobulin fraction of inadequately heated milk which exerts a strong depressing effect on

loaf volume and which is destroyed by high-heat treatment. Further evidence indicates that high-heat treatment improves the baking quality of the casein fraction of milk through interaction with the beta-lactoglobulin of milk.

A significant proportion of nonfat dry milk is manufactured with preheat-treatments in between those for the cottage-cheese type of nonfat dry milk and the bakery-type product. This type of dry milk apparently is suitable for most uses, such as in prepared mixes, confections, sausage, etc. For many of these, specific requirements which the dry milk must meet have not been as well defined as those for the bakery type or the cottage-cheese type of product. In most cases the preheat-treatment may not be of significant importance. The term medium-heat has been used to refer to spray-process nonfat dry milk made from milk which has received an intermediate preheat-treatment.

Depending upon the amount of heat applied, a multiplicity of physicochemical changes occur in the milk during the process of preheat-treatment. Stated briefly, among these changes are 1) destruction of bacteria, 2) inactivation of certain enzymes, 3) denaturation of the heat-labile whey proteins, 4) slight increase in viscosity, 5) definite increases in sulfhydryl and other types of reducing substances, 6) interaction between protein components, and 7) limited reaction of lactose with proteins and other constituents in the so-called browning reaction. Some of these changes have been studied as means of assessing dry milk products with respect to the degree of preheat-treatment. The denaturation of whey proteins (to be discussed later) has been found very useful for this purpose.

Processing Operations: Condensing

Except in some roller-drying operations, the milk after preheat-treatment is condensed under reduced pressure to remove as much water as possible before drying. This is done to increase the capacity of the drying equipment and reduce operating costs. In the manufacturing of spray-process nonfat dry milk, the final solids concentration of the condensed milk may range from about 35 to 45%. The degree of heat-treatment of the milk during condensing will vary with

the equipment used and the processing procedure. Milk in the evaporator may be subjected to a temperature varying from about 80°F. in the new ammonia-operated evaporator to over 185°F. in the first effect of triple-effect evaporators. The length of time the milk is in the evaporator also varies, depending on the efficiency of the equipment.

Some of the physicochemical changes mentioned above in connection with preheat-treatment proceed much more rapidly and extensively when milk is heated in the concentrated state. This is particularly true of the increase in viscosity of the milk. The effect of condensing, plus the high preheat-treatment of the fluid separated milk, generally gives bakery-grade spray nonfat dry milk a rather high water-absorption capacity. Thus, in bread-baking the usual practice is to add one pound of water per pound of dry milk used in the dough. The water absorption of spray-process nonfat dry milk can be further increased by heat-treatment of the condensed milk, an operation referred to as superheating. The water-absorption capacity of the superheated product is higher than that of ordinary high-heat nonfat dry milk, but somewhat lower than that of the roller-process nonfat dry milk. In making the superheated product the condensed milk prior to drying is heated, generally with steam, to about 200°F. or until desired viscosity is obtained. This increase in viscosity is due to the destabilization of the caseinate system. Care is taken not to carry the heat-treatment too far, because this causes protein coagulation and loss of solubility.

Not much information is available about superheating and its effect on baking behavior of the nonfat dry milk. Rogers and co-workers (6) reported that baking properties of nonfat dry milk were not further improved by superheating the concentrate, if the milk had had the proper preheat-treatment. The work of Larsen *et al.* (5) indicates that high water-absorption capacity alone is not an indication of good baking quality; proper preheat-treatment of the fluid milk prior to condensing is of greater importance. This is due to two facts: 1) that the whey protein fraction of milk, in which the loaf-volume depressant appears to reside, is much less affected by concentration than the

caseinate system; and 2) that it is possible to heat milk in the condensed state to obtain good water absorption without adequately denaturing the whey proteins. High water-absorption capacity, however, may contribute to improvement in handling qualities of doughs. This problem is of great interest to the dry milk industry, because certain customers are purchasing nonfat dry milk for bakery uses on the basis of water-absorption characteristics.

Drying by the Roller Process

Two types of drying process are now in use: roller and spray. In addition to these the new process known as "instantizing" has been developed recently for improving the dispersibility of dry milk. Strictly speaking, this is not a primary drying process but a method of aggregating or agglomerating spray-process nonfat dry milk.

In the early days of the dry milk industry, the roller process was almost exclusively used for drying milk because it can be performed on a small scale and requires little space in the plant. In recent years this method has been steadily losing ground to the spray-drying process. Thus, in 1957, less than 10% of the total dry milk production was made by the roller process.

In the atmospheric roller or drum-drying process, the fluid or condensed milk (2:1 concentrate) after proper heat-treatment is fed into a trough formed by two rolls revolving in opposite directions and heated by steam under pressure. The speed of rotation and temperature of the rolls, as controlled by the steam pressure, are regulated in such a manner that the milk dries in a thin film before the roll completes a revolution. This film is continuously scraped off and pulverized into a fine powder.

Although the film of milk on the roll dries in a matter of seconds, the milk in the trough is continuously boiling. Therefore, the temperature of the milk is slightly above 212°F. and increases somewhat as the milk is concentrated during the drying process. At this high temperature and concentration, the proteins coagulate with some loss of solubility of the product. It is of interest to note that even under these rather drastic conditions the fluid milk must be preheated to 185°F. for 30 minutes (or the equivalent) before roller-drying, if the finished

product is to be used for baking purposes. Apparently, the heat-treatment received in roller-drying is not adequate to denature the whey proteins sufficiently because of the rapidity of the drying process.

The vacuum roller dryer is similar to the atmospheric roller dryer with the exception that the rolls are enclosed in a vacuum chamber, to give more rapid drying at a lower temperature and thus minimize protein coagulation and loss of solubility. Very little, if any, vacuum-roller dry milk is being made at the present time.

Drying by the Spray Process

By far the largest proportion of dry milk products manufactured in this country are made by the spray process. Although there are different types of spray dryers, varying in shape, size, method of atomization, and collection of the final dry product, they are all based on three essential operations—namely, atomization of the condensed milk into the drying chamber, evaporation of the water from the droplets by means of a stream of dry heated air, and separation of the dry particles from the gases.

In the spray-drying process, the condensed milk from the evaporator is pumped into the dryer after being forewarmed to approximately 160°F. The milk is atomized either by a centrifugal disk or by a high-pressure nozzle. The temperature of the air into which the milk is sprayed may vary, depending upon dryer design, but usually is between 200° and 300° F. Because of the tremendous surface area presented by the finely divided droplets, evaporation of water is almost instantaneous. Furthermore, this evaporation produces a cooling effect, so that the temperature of the droplets is generally below 150°F. Consequently, in a properly designed and operated spray dryer, there is very little opportunity for heat-damage of the milk constituents. After drying, most of the product falls to the bottom of the dryer and is removed by various means. The fine particles which are carried with the air current are recovered by various collection systems such as cyclones or filter bags. The powder is usually cooled before packaging.

Instantizing

The instantizing process is a recent

development in the dry milk industry designed to improve the dispersibility of spray-process dry milks. Although ordinary spray-process nonfat dry milk is over 99% soluble in water, a certain amount of agitation is necessary for complete dispersal of the product because of its tendency to ball up and lump together, a condition which prevents other particles from making contact with water.

Two methods have been used for making nonfat dry milk "instant" or highly dispersible. The more common method is that of taking spray-process nonfat dry milk, rewetting it with steam, and redrying the aggregates to the desired moisture content. In this process, the small particles are agglomerated into large particles or clusters. These particles, when added to water, permit rapid penetration by the water and complete dispersion. Another method involves the direct spray-drying of large particles. This is done by means of a special or modified spray dryer, in which drying and agglomeration are accomplished in one operation.

Thus far the instantizing process has been confined mainly to nonfat dry milk, but considerable work is being done on instantizing dry whole milk. At the present time, instant nonfat dry milk is marketed mainly in small packages for home and institutional use because of the marked advantage of having a product with good dispersibility. For baking and other uses where the dry milk is blended with other ingredients, there is apparently very little advantage in the instantized form.

The different conditions employed in the three drying processes give products of somewhat different properties. Spray-process dry milk particles are small, uniform, and round, ranging from sub-sieve size to approximately 150 microns. With adequate agitation the product is over 99% soluble. Roller-process particles, on the other hand, are irregular in shape, generally not so fine as those of the spray product, and relatively more insoluble because of the high degree of protein destabilization. The instant product resembles the conventional spray product, with the exception that the particles or agglomerates are larger in size, the packing density is lower, and dispersibility and wettability are greatly improved. As far as composition and nutritional

value are concerned, the three products are practically equivalent.

Product Evaluation

As the above discussion indicates, we have a variety of dry milk products differing in composition (nonfat dry milk, dry whole milk, dry buttermilk), in drying process (spray, roller, instant), and, for spray-process dry milk, in the degree of heat-treatment (low, medium, high, and superheat). Standards for identification and grading of nonfat dry milk, dry whole milk, and dry buttermilk made by the different drying processes, practically the same as those promulgated by the U.S. Department of Agriculture, have been established by the industry. They cover fat, moisture, titratable acidity, solubility, bacterial estimate, scorched milk particles, and flavor and odor. Grading requirements for dry whole milk may, in addition, include copper, iron, and oxygen (depending upon the method of manufacture and packaging), because of the importance of these elements in the oxidation of butterfat. For dry buttermilk, alkalinity of the ash is included as an indication of whether the product was derived from sweet-cream buttermilk.

The various grading requirements mentioned above are designed primarily as quality standards. While in some uses they are sufficient, there are specific applications in which the grading requirements alone are not adequate to determine the suitability of the product. For the purpose of classifying nonfat dry milk into the various heat-treatment categories, the whey protein nitrogen test, originally developed by Harland and Ashworth (1) and recently modified by workers at the University of Minnesota in cooperation with the American Dry Milk Institute (4), has been found to be extremely useful. This test is based upon the fact that the whey or serum proteins of milk are heat-denaturable. Since the extent of denaturation increases with increase in temperature and time of heating milk, the amount of residual or undenatured whey protein nitrogen has been used as an indication of heat-treatment. The following heat-classification for spray-process nonfat dry milk has been recommended by both the U. S. Department of Agriculture and the dry milk industry:

Class	Whey Protein Nitrogen mg/g
High-heat	not over 1.50
Low-heat	not less than 6.00
Medium-heat	1.51 to 5.99

The uses for these three types of nonfat dry milk have been discussed briefly. High-heat nonfat dry milk is manufactured primarily for the baking industry. According to the original study made by Harland and Ashworth (1) and also extensive data obtained in our own laboratory, the maximum limit of 1.5 mg. whey protein nitrogen (w.p.n.) per g. appears to be satisfactory for determining the suitability of nonfat dry milk for bread-baking. Although the test is not specific for baking quality, there is a certain parallel between w.p.n. values and baking quality. In their original evaluation of the test, Harland and Ashworth found that among 18 samples of nonfat dry milk of good baking quality, 15 had undenatured whey-protein-nitrogen values between 0.67 and 1.40 mg. per g. On the other hand, in 14 of 17 samples of poor baking quality, the w.p.n. contents ranged from 1.86 to 6.59 mg. per g. In a study made in the American Dry Milk Institute's laboratory, in which 159 samples of both spray-process and roller-process nonfat dry milk were tested, only one of the 24 samples, which were considered of poor baking quality by laboratory baking tests, had a w.p.n. value below 1.5 mg. per g. Most of the samples of good baking quality had w.p.n. values below 1.5 mg. per g. However, a number of samples above this limit also gave good baking performance. Therefore, on the basis of the limit of 1.5 mg. per g., the Harland-Ashworth test is a simple and useful test for selecting nonfat dry milk for bakery uses.

Several tests such as those with the farinograph, mixograph, and Extensograph®, have been suggested for evaluating the effects of nonfat dry milk on the water-absorption and handling qualities of doughs. Of these, the farinograph test of Hoffman *et al.* (2) is, so far as we know, the only one being used at present as a basis for specifications. The farinograph is essentially a continuous dough mixer in which the force required to mix a dough is continuously measured and recorded. In the Hoffman method an equal mixture of flour and nonfat dry milk is used. The

two quantities measured are 1) development time, which is the time necessary for the dough to reach a consistency equivalent to 500 B.u. with an initial absorption of 65% for roller nonfat dry milk and 40% for the spray product; and 2) the maximum water absorption of the dry milk. The rating of the nonfat dry milk is based upon the values obtained for these two quantities. High absorption value and short development time for nonfat dry milk are desired by some bakeries.

The value of the farinograph test in indicating baking quality has not been so well established as the whey protein nitrogen test. In a collaborative study made several years ago, it was found that the ratings of dry milk samples for baking quality by the farinograph test by seven laboratories were very undependable; results from different laboratories varied widely. As pointed out previously, good water absorption does not necessarily mean good baking quality, since increased water absorption can be obtained by heat-treatment of the condensed milk or by roller-drying without adequately denaturing the factor in the whey protein fraction of milk, which is responsible for low loaf volume. The farinograph test, however, may be useful in predicting the handling qualities of bread doughs made with nonfat dry milk.

The above discussion has been confined to the evaluation of nonfat dry milk for bakery uses. For cottage cheese manufacture the Harland-Ashworth test, in conjunction with the tests which have been developed for measuring curd tension and starter activity, is very useful. For other applications, however, the requirements which nonfat dry milk must meet have not been so well defined and perhaps are not so critical as those for baking and cottage cheese.

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RELATION OF LYSINE CONTENT TO PROTEIN QUALITY OF WHEAT-BASED FOODS¹

N. W. FLODIN, Electrochemicals Department, E. I. du Pont de Nemours & Company, Wilmington, Delaware

AMERICANS HAVE BEEN called the most nutrition-conscious people in the world, and this is probably true. We have been made so by a generation of exciting and well-publicized discoveries, first in vitamin and mineral nutrition, and more recently in protein and fat metabolism. Most of the popular newspapers and magazines have food columns, and frequently publish articles on nutrition. The federal and state governments, insurance companies, and medical editors bombard us with admonitions to avoid obesity and to make sure our intakes of essential nutrients are adequate. Not the least of the forces making for high nutrition consciousness among the general public is the advertising of food and pharmaceutical concerns.

Under these circumstances, no branch of the food industry can afford to let the medical profession and the public remain ignorant of the nutritional value of its products, except at peril of loss in sales and public favor.

At present, flour and bread are far too often associated in the public mind, and even among the medical profession, with the opprobrious terms "low-protein," "carbohydrate food," "starchy," and "fattening." These are damaging terms, and there is little likelihood that an increasingly nutrition-conscious public will show greater acceptance for wheat foods until it is convinced that these foods are truly good sources of protein and not of a disproportionate amount of calories.

Protein Quality and Quantity

There are two aspects to the nutritional value of the protein in a food; namely, its quantity and its quality. Many people have not appreciated the fact that wheat contributes quite a respectable quantity of protein to the diet.

TABLE I
PERCENTAGE OF PROTEIN CALORIES IN VARIOUS FOODS

Food	CALORIES FROM PROTEIN
	%
White rice	8.4
Corn meal, degermed	8.7
White bread flour	12.9
White bread, 4% nonfat dry milk	12.4
Protein bread	15-25 ^a
Whole milk	21.0
Ground beef, cooked	24.2
Whole egg	31.6

^a Depending on content of wheat gluten, soy, and milk protein.

This is shown in Table I, which gives the percentages of calories from protein contained in several common foods (25). Wheat is substantially better than rice or corn as a protein source and actually provides about the same percentage of protein calories as a rather good American diet. According to Dole, the percentage of protein calories in typical American diets, as well as in average diets of 32 other countries, varies from 10 to 13% in nearly all cases (9), whereas bread flour provides 12.9%.

Many nutrition authorities are recommending that

about 15% of dietary calories be in the form of protein for children, adolescents, and pregnant women (17, 19, 23). It is relatively easy to raise the level of protein calories in bread, macaroni, and other wheat foods to 15% or higher by adding wheat gluten, milk, or soy protein. Highly palatable protein breads can be made that provide 20% or more of protein calories, a level comparable with that of meat or milk.

Protein Efficiency and Amino Acids

It is not sufficient, however, to compare protein sources simply on the basis of their percentage of protein calories. Their biological value or protein efficiency must be taken into account. As is now generally accepted, this is primarily a function of the amino acid pattern of the food (10).

Not as much is known about the optimum amino acid pattern for humans as we would like. W. C. Rose has done pioneering research to determine the minimum short-term maintenance requirements of adult college men (20). Compared on a proportionality basis with Rose's data on amino acid requirements, wheat protein does not look bad. For example, the lysine-to-tryptophan ratio of Rose's requirements is 3.2, about the same as the ratio in white bread made with 6% nonfat dry milk.

However, it is already known, from the research of Mertz and co-workers, that if adult men are kept on a low-nitrogen experimental diet for 20 to 30 days instead of the usual week or ten days, the lysine requirement goes up (7). Presumably what takes place during the experimental period is that lysine needs are partially met for a time by shifts of lysine from short half-life proteins in the body to more stable proteins. After these labile proteins are depleted, the lysine requirement increases to some extent. How far is not yet known.

Also, the present minimum requirements for amino acids were determined when the subjects were receiving abnormally high calorie intakes. The Purdue group has already determined that the requirement for lysine increases as the calorie intake is reduced toward normal levels (8).

Full Nutrition vs. Protein Depletion

Whatever the long-term minimum maintenance requirement turns out to be, it must still be recognized as a minimum requirement in an organism depleted of labile protein reserves. Figure 1 shows the protein requirements of the adult dog when in a depleted state and when well nourished. These were determined by Allison (2). The requirements differ, depending on the kind of protein, being lowest for egg and highest for wheat. Note, however, that it takes about three times as much egg protein to keep a dog in a state of full nutrition as in a depleted state. In egg, all the essential amino acids, including lysine, are

¹ Presented at the 43rd annual meeting, Cincinnati, Ohio, April 1958.

considered to be in good balance with the dog's needs. Hence, it is obvious that the requirement for lysine is about three times as high for an animal with full protein stores as for one with depleted stores. The same holds true for the other essential amino acids.

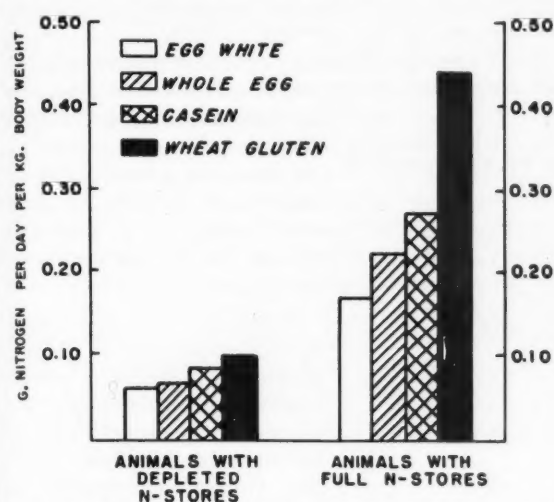


Fig. 1. Minimum protein requirements of adult dogs, based on data of Allison (2).

It seems probable, therefore, that the long-term minimum requirements of amino acids for adult humans at normal calorie intakes will turn out to be substantially higher than the values now available, at least for some of the amino acids, and that optimum requirements for full labile protein stores will certainly prove to be much higher than the present figures.

In addition, at low intakes of amino acids, the diversion of methionine to methylation reactions and of tryptophan to niacin synthesis may account for a significant portion of the minimum requirement, distorting the over-all amino acid pattern as far as growth and repletion are concerned.

Minimum adult requirements for the rat, comparable to those of Rose for the human, are known through the work of Nasset. He found that an amino acid mixture patterned after these requirements was much less efficient for tissue repletion in the rat than a mixture patterned after egg (18).

For all these reasons, it appears we must take as our standard for a good amino acid pattern a protein that is known to have high biological

value and to support good growth in humans. Egg protein is a common standard of comparison, though the amino acid patterns of meat, fish, and milk are quite similar and known to be good for human nutrition (10).

Wheat protein has an amino acid pattern that compares favorably with these animal proteins except for a shortage of lysine. It has a low biological value in adult humans, but can be made almost as good as casein by lysine supplementation (13). Albanese and co-workers report that wheat gluten gives poor growth and nitrogen retention in infants, but can be made as good as milk by lysine supplementation (1). Since the body proteins of mammals contain in the neighborhood of 9% lysine, it is to be expected that a fairly high level of lysine in the dietary protein would be needed for good efficiency of protein utilization (5).

German Orphanage Nutrition Study

A study by Widdowson and McCance on German orphanage children about 10 years of age, consuming unrestricted diets largely based on wheat, indicated normal height gains and greater weight gains than in American children of the same age, as shown in Figs. 2 and 3 (26). Prior to coming on experiment, the children had been living on diets restricted in calories as well as other nutrients. The more abundant diet, as indicated by the curves of Figs. 2 and 3, at first produced greater-than-normal increases in height and especially weight, followed by a "flattening-out" trend toward the normal as the experiment progressed. Hemoglobin levels, hematocrit values, and pseudo-cholinesterase levels in the blood were lower

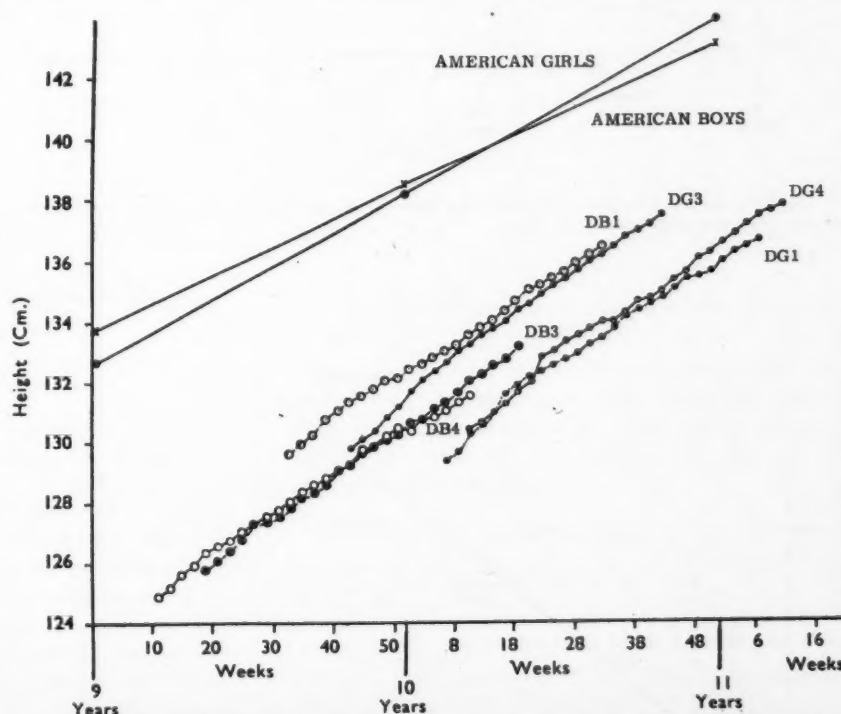


Fig. 2. Absolute growth in height of some of the children at Duisburg, compared with the American standard. Legend: DB, Duisburg boys; DG, Duisburg girls; 1, flour of 100% extraction; 3, flour of 70% extraction; 4, flour of 70% extraction enriched to 100%.

than those observed in British children of the same ages at the start and remained so at the end of the experiment. Albumin/globulin ratios were in the range of 1.8-2.0 at the beginning of the study and failed to rise. This failure of blood protein and enzyme values to increase is an indication that the dietary protein was not adequately meeting the children's needs.

The normal height gains observed in this study are not surprising, as reports from various protein-poor areas,

such as Central America and India, indicate that children in the 6- to 14-year age period grow at rates parallel to those of American children after initial stunting in the first few years of life (22, 24). The skeletal growth rate is modest in this period as compared with the rate in early childhood and adolescence, and can be fairly well maintained by poor-quality protein.

The Widdowson-McCance study in no way negates the fact that children who live mostly on wheat, as many do in Newfoundland, Italy, and Chile, among other countries, are stunted in growth and final adult height as compared with other children of the same nationality who get adequate animal protein.

Allison has shown that young growing dogs gain a normal amount of weight on a wheat gluten diet, but store much less nitrogen and deposit much more fat than animals on milk or egg (3). Certainly the protein intakes and the protein quality, due to shortage of lysine, in the Widdowson-McCance study were substantially below those which Stearns and co-workers found necessary to secure normal muscle development in children (23).

There is no reason, therefore, to believe that the optimum amino acid pattern for man is much different from that for other omnivorous mammals, such as the rat. Actually, there is rather good correlation between biological value data for humans and protein efficiency ratios determined in rats, as shown in Fig. 4. The protein efficiency ratios, representing grams weight gained by the growing animal divided by grams of protein consumed, are those tabulated by Block and Mitchell (4). Biological values in adult humans were determined by Murlin and co-workers (11, 12).

Estimating Protein Value

In view of this correlation, it appears practical to estimate the value of a protein for the human by determining its protein efficiency for rat growth. We have carried out a number of

Fig. 3. Absolute growth in weight of some of the children at Duisburg compared with the American standard. Legend same as for Fig. 2.

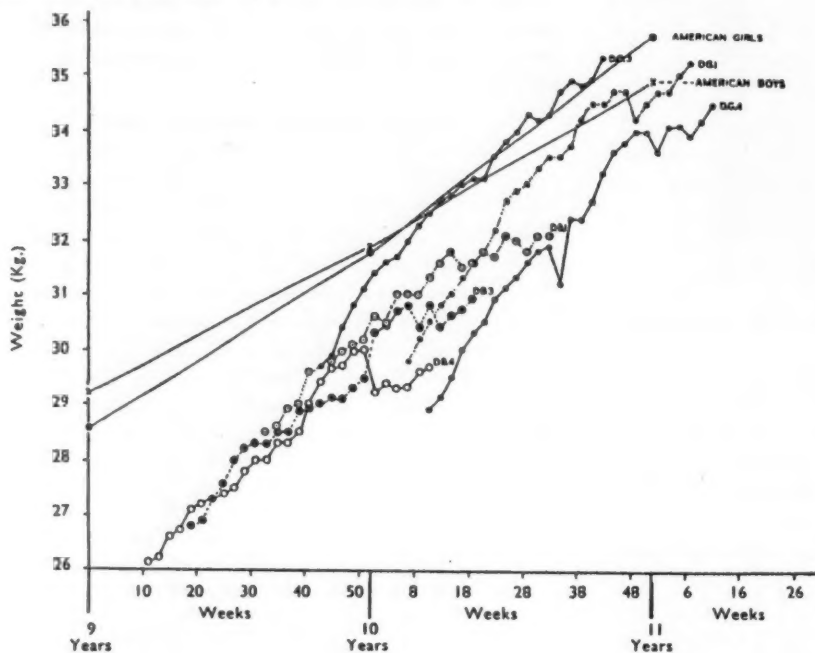
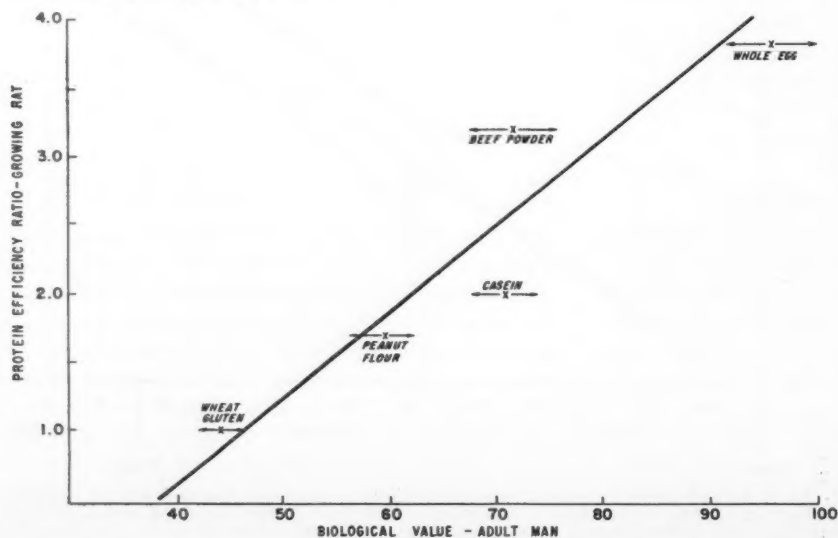


Fig. 4. Comparison of protein evaluation using growing rats and adult humans. (References: protein efficiency ratio, 4; biological value, 11, 12).



growth studies of this kind with bread containing varying supplement of wheat gluten, milk, and soy protein. Our work indicated that lysine supplementation, at the rate of $\frac{1}{4}$ lb. of *L*-lysine monohydrochloride per 100 lb. of flour, substantially increased the protein efficiency even when 30 to 40% of the bread protein came from milk and soy and the remainder from flour and wheat gluten. It also indicated that the protein efficiency of these food combinations is a direct function of the percentage of lysine in the protein, whether the lysine was present in protein-bound form or as free lysine.

Figure 5 summarizes the results of studies carried out by five different groups of investigators with 28 groups of animals on wheat flour, mixtures of flour with nonfat milk solids and lysine, and bread baked with various supplements including wheat gluten, nonfat dry milk, soy flour, and lactalbumin, with and without added lysine (6, 14, 15, 16, 21). These studies were all carried out with diets containing 11 to 12% protein, supplemented with vitamins, minerals, and essential fatty acids. However, they were done in different localities, at different times, and with different strains of rats. Under these circumstances the correlation is quite impressive.

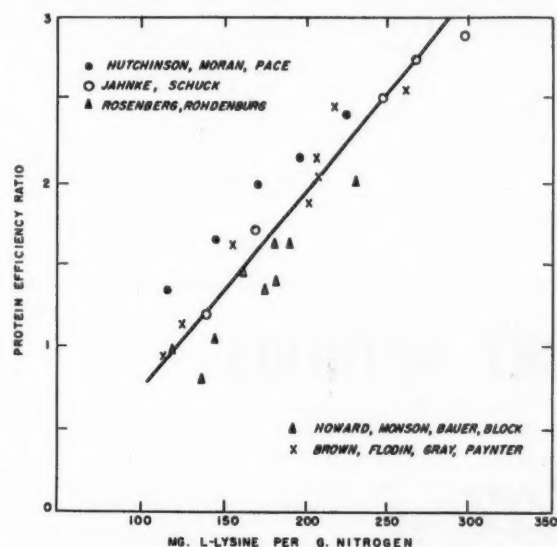


Fig. 5. Relation between protein efficiency and lysine content of bread protein. (References: 6, 14, 15, 16, 21.)

From these data, it would now appear possible to bypass the rat growth study in estimating the protein value of combinations of wheat, milk, and soy as usually found in the standard types of bread and high-protein breads, as well as in such combinations as macaroni and cheese or farina and milk. A determination of the percentage of lysine by microbiological assay and of nitrogen by Kjeldahl analysis will suffice for a calculation of the protein efficiency ratio, with a precision about as great as normally obtainable by a 4- or 5-week growth study with young rats on a diet providing 11 to 12% protein calories.

For protein efficiencies in the high-quality range of 2.5 ± 0.5 , comparable to many common animal proteins, it

would appear necessary to have about 245 ± 40 mg. of nutritionally available *L*-lysine per g. of nitrogen in the mixed protein of protein breads, macaroni and cheese, or wheat cereal and milk mixtures.

Wheat Foods Can Be High in Protein Quality

It is clear, therefore, that manufacturers of wheat foods are now in a position to overcome allegations that their products are simply carbohydrate foods, low in quantity and quality of protein. The percentage of protein calories can be made as high as that of many animal protein foods by adding wheat gluten, milk, and soy protein. When milk and soy are added, not only the percentage of protein, but the percentage of lysine in the protein, is increased. Lysine concentrations high enough to give animal protein quality can be readily attained by addition of *L*-lysine monohydrochloride.

Since protein and lysine supplements to bread will add to the ingredients cost, it is of interest to compare the retail price of high-quality protein in the form of improved bread with the prices of high-quality protein from other foods. High-quality protein is the most expensive food ingredient that we buy. Pure carbohydrate and fat are relatively inexpensive, and the market value of a day's intake of vitamins and minerals is negligible. Table II therefore shows a comparison of what the consumer currently pays in cents to obtain 1 g. of high-quality protein from various common foods.

TABLE II
RELATIVE RETAIL COSTS OF COMMON FOODS PER GRAM OF HIGH-QUALITY PROTEIN

Food	Protein per pound ^a	Price per pound ^b	Cost per gram high-quality protein
	g		cents
Cottage cheese	88.5	\$0.36	0.41
American cheese	105.3	0.59	0.56
Protein bread with lysine	60.0	0.35	0.58
White bread with lysine	39.0	0.23	0.59
Ham, smoked	76.7	0.59	0.77
Fresh whole milk	15.9	0.125	0.79
Ground beef	73.0	0.69	0.95
Frankfurters	64.5	0.69	1.07
Eggs, medium	51.7	0.56	1.08
Round steak	88.5	0.99	1.12
Porterhouse steak	64.0	0.77	1.20
Pork chops	60.4	0.99	1.64

^a From "Composition of Foods" (25).

^b Supermarket prices in Wilmington, Del., Oct. 1, 1957. Bread prices assumed arbitrarily.

It can be seen that, at prices allowing for the added ingredients cost of supplements, white bread and protein bread with supplementary lysine offer two of the most economical sources of high-quality protein that can be made available to the consumer.

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3. The amount of coloration obtainable by this technique is within a practical range.

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Thomas E. Colbert, David Kollander, Erlend R. Lowrey, and William J. Schumacher join development department, food division, Procter & Gamble.

Joe DeHaan transferred from Tacoma to Los Angeles plant of General Mills, Inc.; will assume duties of products control manager. W. C. Mailhot takes on the same position at the Tacoma mill. Don Colpitts will finish Joe DeHaan's term of office on executive committee of Pacific Northwest Crop Improvement Association.

A. Mason DuPre, Jr., appointed assistant to the administrator of Agricultural Research Service; from assistant director of Southern Utilization Research and Development Division, New Orleans, since 1946.

Roy K. Durham to retire March 1 as manager of flour quality control, The Pillsbury Company; will serve in advisory capacity until then and continue service on consulting basis to food industry.

Albert L. Elder, voted president-elect, American Chemical Society; is director of research for Corn Products Co. Succeeds John C. Bailar, Jr., who becomes president for 1959.

A. J. Lejeune, executive director of Malting Barley Improvement Association, announces that all officers have been reelected: Stuart F. Seidl, pres.; Herbert Kurth and James G. Shakman, vp's; A. J. Goede, treas.; and Thelma Richards, sec. W. W. Sisler and R. L. Upton to continue as agronomists.

Albert W. Merck appointed assistant to executive vp of Merck & Co., Inc., with responsibilities in company marketing problems; from director of advertising and promotion, Merck Chemical Division.

F. Warren Tauber, manager food and packaging research department, Visking Co., elected to board

of directors and executive committee of Research and Development Associates, Food and Container Institute, Inc.



Director of cake service section.

D. B. Pratt, Jr., AACC president-elect, named new manager of flour quality control department, The Pillsbury Company, succeeding Roy K. Durham; from technical director of cake service section.

• • • Products

Laboratory balances. A recently issued 32-page Balance Bulletin is available free upon request from Harshaw Scientific, Division of The Harshaw Chemical Co., 1945 E. 97th St., Cleveland 6, Ohio. This book illustrates and describes their complete line of laboratory balances, balance weights, and accessories.

Bulk materials handling. Catalog No. 7, just out, describes the Tote System of equipment for handling materials—bins, tanks, tilts, and accessory equipment for automatic filling and discharge; in inter- and intra-plant operations, and for both batch and continuous process handling. Concrete examples are given to show how the system is designed to save labor, container, and shipping costs and reduce warehouse space requirements. Various methods of transporting the unit containers are described. A 20-page illustrated booklet, available from F. P. Walther Jr. and Associates, Inc., 147 E. 50th St., New York 22.

Spray-dried vital gluten. With a new method of processing, Midwest Solvents Co., Inc., of Atchison, Kansas, produces finished vital gluten by continuous spray-drying. The dry gluten, called Midsol gluten, has the same texture as flour and is said to retain all of its native

properties and regain its original vitality or elasticity upon being reconstituted with water. The spray-dried product is claimed to give remarkably good loaf volume, with other properties equal to or better than those obtained with conventionally manufactured vital gluten. The process uses a dispersing agent which disappears during the spray-drying operation, and which breaks up the particles so they remain suspended within the solution prior to drying. The resulting powder is described as free of foreign odors, tastes, and contaminating substances.

High-amylose corn, or "amylo-maize," is now being produced in research quantities, opening the way to far-reaching possibilities in the production and use of new types of starches. National Starch Products, Inc., and American Maize-Products Company are co-venturers in the project. Some of the possibilities seen for the near future are 1) water-soluble transparent film wrapping for frozen foods, meats, and other edible products to be cooked in the wrappings; the amylo-maize film will dissolve as the contents are cooked, and is completely digestible; 2) packaging material for water-dispersible products such as detergents, dyes, insecticides, and industrial chemicals to replace the more expensive water-soluble synthetic films; 3) nonwater-soluble starches for coating and surface-treating paper and paper products. Company executives state that the amylose content of starch from the newly developed corn is 55%, and the starches show superior performance to previous types in all uses requiring film formation.

Spectrofluorometers, dual- and triple-purpose. Farrand Optical Co. announces two new types of spectrofluorometer in addition to its standard model. One is a dual-purpose instrument for transmission measurements in the spectral region from 220 to 650 millimicrons. The second is a triple-purpose instrument which can be used as a spectrofluorometer or a spectrophotometer, for reflectance measurements of solid samples such as textiles, plastics, paints, paper, and powders. They can be supplied for manual operation, for automatic operation with recorders, or for oscilloscope presentation. Descriptive bulletin No. 820, Supp. 1, is available on request from: Dept. C-4, Farrand Optical Co., Inc.,



NUTRITION

NEWS FROM

Pfizer

Quality Ingredients
For the Food Industry
For Over a Century

TECHNOLOGISTS SEE NEED FOR FORTIFICATION OF FOODS SUCH AS BREAD AND PROCESSED CEREALS WITH VITAMIN B₆

While a "minimum daily requirement" has not yet been established for Vitamin B₆, the most recent data suggest the human need for this nutrient may be even greater than for thiamine and riboflavin. A composite of recent studies indicates that as much as 2-7 mg. of B₆ may be desirable in the daily diet.

Although Vitamin B₆ is widely distributed in foods, a large portion appears to be lost or destroyed during processing or cooking. One study contrasting the B₆ content of wheat fractions shows that while whole wheat flour contains approximately 2.09 mg./lb. of B₆, patent flour contains only 0.99 mg./lb.—a loss of 50% B₆ content through processing. Almost all white breads on the market today contain only 0.45 mg. of B₆ per one pound loaf. When you add to this the fact that meat in cooking has been found to lose as much as 57% of its B₆ content and that canning and processing of foods markedly reduces their natural B₆ content, you can see evidence of a marginal B₆ intake in the diet today.

There would appear to be good reason for food processors to consider fortifying their products with Vitamin B₆.

If you would like further information

on this subject, write Pfizer for a copy of Technical Bulletin 96 and "VITAMIN B₆—The Case for Dietary Enrichment."

★ ★ ★

New Facts About Lysine Supplemented Bread

The quality and efficiency of wheat protein can be markedly improved by supplementation with the essential amino acid, L-Lysine. (Pfizer produces L-Lysine by a unique fermentation process assuring highest quality.)

A recent nutritional report compared the protein quality and quantity of white bread, protein bread and egg. It shows that nine slices of ordinary white bread are required to equal one egg in terms of quality and quantity of protein. If white bread is supplemented with lysine, only five slices equal one egg.

The report shows that protein breads can be improved in a similar manner. If protein bread is supplemented with lysine, three and one half slices instead of five provide the same protein quantity and quality as one egg.

If you would like further information on lysine supplementation of bread and

other products such as breakfast cereals, write to Pfizer for Technical Bulletin 89, "L-Lysine Monohydrochloride."

★ ★ ★

New BI-CAP® Enrichment Concentrate For Cornmeal

PFIZER BI-CAP® was one of the first enrichment concentrates. And this "head start" in vitamins has continued. It means that Pfizer can help you with the newest developments in enrichment products.

PFIZER BI-CAP has recently been improved through vitamin research. It is now a lighter colored enrichment mixture with an even riboflavin dispersion that overcomes unsightly agglomeration.

A new addition to the BI-CAP enrichment line is BI-CAP Bolted Cornmeal Enrichment. Pfizer also continues to offer its BI-CAP Degerminated Cornmeal Enrichment plus both single and double strength flour enrichment mixtures. If you would like further information write CHAS. PFIZER & CO., INC., Chemical Sales Division, 630 Flushing Avenue, Brooklyn 6, New York. Branch Offices: Chicago, Ill.; San Francisco, Calif.; Vernon, Calif.; Atlanta, Ga.; Dallas, Texas

Bronx Blvd. and E. 238th St., New York, N. Y.

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Yields boosted by "Gibrel." Profitable returns and increased yields in western cotton areas where Gibrel is included in cultivation practices were reported recently. James M. Merritt, manager of plant products development, Merck & Co., Inc., Chemical Division, said that belt-wide tests have been under way for two seasons, and that "the effect is in the highly profitable range." The report continues: "The use of Gibrel on citrus has doubled fruit set on navel oranges, and juice has been increased 9%, ascorbic acid 13%." Merck is working with the University of California at Riverside to increase the juice content of grapefruit and lemons, and to increase the juice in oranges without color loss. In reviewing prospects for the future role of Gibrel in agriculture, Dr. Merritt said that small grains and grasses look much more promising than first expected.

"A fascinating field is being developed," he concluded, "and positive effects on agricultural production are maturing. It challenges the industry, as much as the farmer, for skilled field service will surely be needed to turn the productivity of this new development into the perennial profits that agriculture and its supplier industries both need."

• • •

Morea® supplement feeding operations on cattle, dairy, and sheep farms in the York-Lancaster (Pa.) area were demonstrated recently to more than 40 feedmen from New York, Pennsylvania, and Virginia. Liquid feeding is a new approach to livestock nutrition, enabling animals to get more to eat in a form they can readily utilize to produce better meat and more milk. Farmers using the supplement have reported rapid weight gains, more efficient feed conversion, and lower feeding costs, according to the manufacturer's statement. The visiting feedmen also toured the plant of Hespeneide and Thompson, Inc., at York, Pa., mixer-distributors, and are among prospective handlers of Morea® supplement as distribution is expanded. Ingredients in the feed premix are urea, ethanol, phosphoric acid, and essential trace minerals. Local mixer-distributors blend the premix with molasses for efficient bulk delivery and convenient use on the farm.

• • • **Patter**

Dairy subsidiaries combined. Management of two Foremost Dairies subsidiaries operating in Wisconsin has been combined because of related operations and geographic proximity: Foremost-Blue Moon Cheese, Inc., of Thorp, Wisconsin, and Western Condensing Co. of Appleton, Wisconsin. Western Condensing Co., managed by Kenneth W. Ward, is a leading supplier of lactose and other milk derivatives, sold as ingredients for foods and pharmaceuticals, to the farm market, and for various industrial uses.

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The Biennial Barley Improvement Conference was held in Milwaukee, Wisconsin, January 20, 1959, at the Schroeder Hotel. The one-day program included reports on progress in the development of superior barley varieties for malting and brewing; results of field and quality tests on new varieties and selections; studies on artificial drying of barley; and surveys of varieties grown in 1958 and the acceptable varieties for planting in 1959. After-dinner speaker was Marion W. Parker, director of Crops Research Division, ARS, USDA, on the subject of "The program of the Crops Research Division."

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Prize-winning essay. At the 22nd annual meeting, Pacific District AOM, held at Hotel Davenport in Spokane October 3 and 4, a prize-winning essay on "The function of cereal chemistry in the milling industry" was presented by its author. He is Richard Fuhr of Centennial Milling Co. Laboratory, Portland, Oregon. The paper described the work of the cereal chemist in the mill and bakery, and pointed out the importance of a closely knit working partnership with the miller. In a synopsis of AACC history, advances in cereal chemistry were reviewed which have enabled today's cereal chemist to control enzymatic activity, measure dough characteristics, determine particle size distribution in flours, and improve the nutritive value of human and animal foods with micronutrients produced by chemical synthesis.

• • •

"Corn Syrups and Sugars." A new edition of the 45-page illustrated booklet with the above title is available to those interested,

revised and updated from the 1956 (original) edition. Chapters deal with types of corn syrups and sugars; the manufacturing process by which they are made; their chemical properties and physical characteristics; approved methods of handling; and an analytical examination of these products. Tables and a glossary supplement the text. Copies are free on request to Corn Industries Research Foundation, Inc., 3 E. 45th St., New York 17, N.Y.

New chemical laboratory. Offices and laboratory of Chemlab, Inc., have opened at 11535 W. Franklin Ave., Franklin Park, Ill., under the direction of Bernard Wolnak. Services offered are consulting and contract research, new product development, process improvement and development, and technical services to all types of industry. Dr. Wolnak takes this step as the culmination of his work in the chemical industry in the Chicago area for a number of years.

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EMPLOYMENT NOTICES

Quality Control Supervisor wanted, Midwestern plant manufacturing flour mixes; training and experience in cereal chemistry or food technology required; knowledge of baking technology and statistical methods desirable; full responsibility for material, process, finished product testing. Salary commensurate with experience. State requirement. Reply to: **CEREAL SCIENCE TODAY**, Box 259, University Farm, St. Paul 1, Minn.

Research chemists wanted, for practical cereal research. Degree in cereal chemistry and some practical laboratory experience necessary. Excellent opportunity with old established company for person with imagination and proper qualifications. Submit resume stating age, experience, education, personal background and salary requirements. All replies held in strict confidence. Our employees know of this opportunity. Reply to: **CEREAL SCIENCE TODAY**, Box 2159, University Farm, St. Paul 1, Minn.

AACC

LOCAL SECTIONS

Central States Section's January meeting (24th) was held at Monsanto Chemical Company's plant in St. Louis. Three members of Monsanto's research department were guest speakers: Paul Hoffman, James F. Conn, and James L. Vetter. At a previous meeting (Nov. 14, 1958), AACC president-elect D. B. Pratt, Jr., spoke on "The baking properties of air-classified flours."

Southern California Section met on December 2 at Rodger Young Auditorium, Los Angeles. Jerry Lincoln of Goch Laboratories in Los Angeles spoke on "Some common mold contaminants in cereal products." He discussed the genera *Aspergillus*, *Rhizopus*, and *Penicillium* and their control, comparing them with respect to morphology and physiology.

New officers elected to serve out terms of others who have left the area are: Joseph H. Topps (former vice-chairman) of California Milling Co., chairman; Ed Brooks, Carnation Research Laboratories, vice-chairman; Jack Lax, Joe Lowe Corp., treasurer; and Ada Marie Campbell, UCLA, secretary.

Northern California Section, meeting on December 12, made preliminary arrangements to select committee chairmen for their joint meeting with Southern California Section at Fresno in April.

A talk by guest speaker Harold S. Olcott, on the use of antioxidants in fats and oils, was a very interesting one. Dr. Olcott discussed methods for determining the rate of oxidation and the effects of various commercial compounds. He pointed out a pronounced synergistic effect of amino compounds, such as proline, when used with various antioxidants.

Guest speaker for the meeting on January 28 is James McGinnis of Washington State College.

Midwest Section's January meeting (on the 5th) was a down-to-earth type of program, an educational workshop on chemical leavening agents, with three program participants from three major companies: Charles Feldberg of Chas. Pfizer & Co.; Tom Kichline of Monsanto Chemical; and James Tucker of Victor Chemical Works. Samples of various leavening agents and of various baked products were on hand for inspection from 4 p.m. at the Builders Club, Chicago. During this time members had an opportunity to confer privately with these technically qualified men and to discuss subjects like specific phosphate leavening systems, the new G. C. Lactone Instant Bread Mix, and the use of various phosphates in quick-cooking cereals, puddings, and dairy products.

A social hour at 5:30 was followed by dinner at 6:30. Each of the three speakers gave a 15-minute presentation of his particular viewpoint and experience and his company's products.

Niagara Frontier Section met Monday evening, January 12, for dinner and business session at the Erie County Technical Institute, Buffalo. A sound film was shown, describing the Wallace & Tiernan "Do-Maker" continuous breadmaking process. The evening was well rounded out with a guided tour starting at 8

o'clock, through the Gioia macaroni plant across the street from ECTI, arranged by a new section member, Henry Deoca of the Gioia Company. The continuous macaroni presses and supplemental equipment were in operation, and those who took part in the tour considered it a most interesting one.

New York Section held their January meeting on the 13th with Mr. Russell Cook, president of Ambrosia Chocolate Co. speaking on "Chocolate and Cocoa Uses for the Baking Industry."

On Tuesday evening, February 10th, the section will hold Ladies Night. An interesting program has been prepared especially for Mrs. Consumer. Mr. Charles E. Herrmann, chief of the New York District of the Food and Drug Administration will address the group on "Watching Over the Nation's Food Supply." The meeting will be held at 6:30 p.m. at the Brass Rail.

OVERSEAS REPORTS



• • • Australia

In Australia, the only association of cereal chemists is one within the Royal Australian Chemical Institute. The cereal chemistry group was the first of such specialized groups to hold interstate meetings and these have proved very successful. The eighth Annual Conference, held in October last, at Horsham, Victoria, was no exception to the established pattern and was attended by delegates from as far afield as New Zealand.

Unfortunately, the Group Chairman, P. J. Meddings, was prevented from attending but his place was ably taken by E. J. O'Brien.

Horsham is in the center of the best-known area in Australia for the production of soft wheat and, appropriately, the conference opened with a symposium on biscuit and cake manufacture.

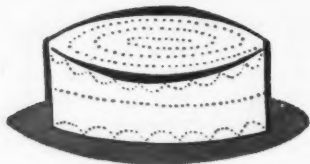
H. C. Gluskie (Weston Research Laboratories, N.S.W.) spoke on "Cake making and baking plant," and criticized the little appreciation shown in Australia for basic research related to the chemical and physical changes involved in cake-making.

M. E. Jones of Peak Frean (Aust.) Pty. Ltd. presented a review paper entitled "Biscuit types and their classical methods of production."

A discussion panel on "Laboratory tests and their application to biscuit manufacture" followed, the main speakers being N. Heron (Brockhoff's Biscuits Pty. Ltd.), and W. B. S. Bishop (William Arnott Pty. Ltd.).

In the following session a series of papers was presented, the first on "Protein structure," by E. O. P. Thompson (Wool Textile Research Laboratories, C.S.I.-R.O.), who described the methods now used for determining the number of peptide chains in a protein molecule, the mode of cross-linking, the order arrangement of amino acid residues and the three-dimensional spatial arrangement of the peptide chains and the flexibility of the protein molecule.

F. J. R. Hird (Department of Biochemistry, University of Melbourne) discussed the action of mild oxidizing and



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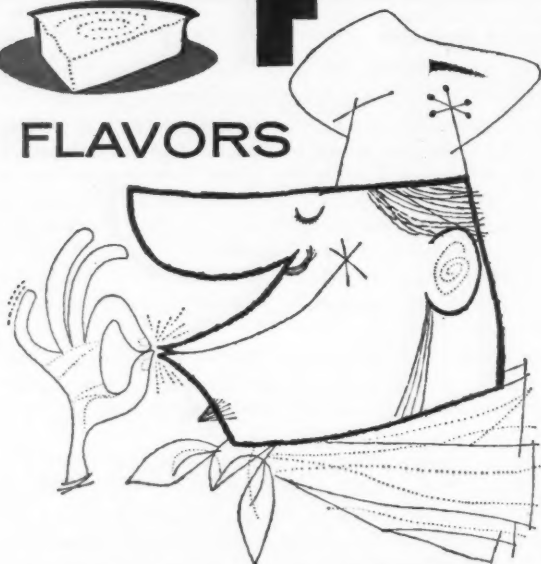


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reducing agents on proteins. He attributed the effect of improving agents in doughs to action on sulfur atoms involving the breaking or forming of cross-linkages.

R. W. Cawley (Wheat Research Institute, D.S.I.R., New Zealand) discussed the work carried out in New Zealand on the biochemistry of dough oxidation.

K. Finlay (Department of Agronomy, Waite Agricultural Research Institute, University of Adelaide) described the fundamental approach being used at the Waite Institute for breeding improved barley varieties, and stated that 1,500 varieties had been examined.

An afternoon visit was paid by the delegates to Longrenong Agricultural College. They were received by the Principal, C. Pym Cook, who outlined the work of the college and conducted a tour of the experimental plots.

D. R. Rooney (Victorian Department of Agriculture) reviewed the wheat-growing practices of the district which are now improving the soil nitrogen level.

Other papers presented at the conference were "A report on the progress of irradiation of foods" by F. H. Reuter (N.S.W. University of Technology); "Irradiation of Australian wheat" by I. M. Norris (William Arnott Pty. Ltd.); "The effects of starch damage in cereal products" by P. Marston (Weston Research Laboratories, S. A.); "Current investigations on starch damage in Victorian flours" by H. J. Moss (Department of Agriculture, Victorian State Laboratories); "Moisture relations in wheat" by E. J. O'Brien (Department of Agriculture, Victorian State Laboratories); and "A new laboratory dough molder" by R. A. Bottomley (Mauri Brothers & Thomson Limited, Sydney).

During the conference the matter of establishing scholarships suited to training in cereal chemistry was discussed and a subcommittee was directed to investigate the possibility of securing funds for the provision of overseas scholarships of this type.

R. A. BOTTOMLEY
Corresponding Editor

BAKING TECHNOLOGY



ERRATUM

CEREAL SCIENCE TODAY, Vol. 4, No. 1
(January 1959 issue)

In the column "Baking Technology," page 22, column 2, paragraph 2, there is a transposition of lines. The first two sentences should read:

"The advantages of this procedure are two-fold: First, it is not necessary to accurately list the time when the peak point is reached. In some cases it is a good deal easier to find the highest point of the curve in units than to determine the actual peak time."

A corner of one of the famous Procter & Gamble laboratories at Ivorydale, Ohio.
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Observations

In response to many requests from both flour mills and our bakery customers, we plan to initiate a semiannual report with complete details as to analyses and baking performance of the brands of flour analyzed in our laboratories. Many flour mills do not submit all of their brands to us, and therefore we anticipate that many flour brands will not be included in our report.



This notice to flour mill chemists will bring to their attention what we expect to do, and perhaps some of the chemists will want to be sure that certain of their flour brands are submitted to us for chemical analyses and baking tests. When submitting samples, be sure that a minimum of 10 pounds is submitted for this type of analysis. Be sure that all brands you want included are in our laboratories before April 1, since we want to get our first report out during the month of April.

We also want to bring another matter to your attention: we now have a thoroughly capable service man, available on short notice, to serve our bakery accounts, flour mill accounts, and companies that have materials to sell to the baking industry. This is a new service Doty Laboratories is offering, and we hope our customers will take advantage of a service man who is laboratory-trained as well as a thoroughly capable production man. His service will be on a flat per-diem expense basis and will be available to any of our customers.

Jim Doty

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ANNUAL MEETINGS

As customary at this time of year our thoughts and efforts are directed to the forthcoming Annual Meeting. We begin to implement the many plans that have been made by the Local Arrangements and Program Committees. These plans have been formulated over a long period—even before the previous meeting has started. But it is only now that these plans start to materialize and develop into the successful scientific sessions that members of the AACC have come to expect.

The tentative program that was published last November in this journal gives every indication that our technical sessions are going to be highly productive. We are going to be told about the latest advances in every phase of cereal chemistry. We are going to hear a lot about the applied or day to day aspects of our business as well as about the strides being made in fundamental cereal research.

All of this information we will find valuable to a greater or lesser extent in our own work in the laboratory or plant. The cereal industry has been given a challenge by the many noncereal foods on the market today. It can meet that challenge by more efficient production, the development of new edible products that are a treat to the tongue as well as the pocketbook, and by applying its skills and talents to the vast potential of nonedible uses of the cereal grains.

Competition is nothing new to the cereal industry. But it behooves all of us to take advantage of every scientific breakthrough either in the development of new products or in the manufacture of old ones by new and better means. We must be efficient and quality conscious, using every opportunity to learn more about our business.

It seems only reasonable to suggest that participation at scientific meetings and technical conferences is a necessity if we wish to remain in-

formed on current advances. The upcoming AACC meeting in Washington, D. C., May 3-7, is the 44th such gathering in the Association's history. It will mark the first time we have ever met in the nation's capital. The timing seems opportune in view of the responsibility we as cereal chemists have in helping to feed the world with high nutritive foods at low costs. We will have the chance to meet with and speak to many of our government leaders. We should take advantage of this opportunity to strengthen the channels of communication between the cereal industry and the government.

Attendance at scientific meetings also involves a responsibility on the part of each of us. We should let management know what we heard, what we saw, and how new developments reported will affect our individual businesses. Meeting prospective customers and ironing out difficulties with present clients will alone justify attendance at any meeting.

PROSPECTIVE MEMBERSHIP SURVEY

A few weeks ago the chairman of the AACC's membership committee, Mr. Don Davis, mailed to all local section chairmen a group of blank questionnaires which when completed will give the committee a good idea of the number of non-AACC cereal chemists. We urge each local section to complete the assignment as rapidly as possible and to do as thorough a job as can be managed within the limits set down. It is vital to have a broad membership base within our own specialty if the AACC is to do the educational job necessary to place the chemist in correct perspective in the eyes of top management. An adequate active membership that represents the majority of the cereal chemists at work is a must if we are to be properly recognized. Please do your part NOW!

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